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A

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CONDUCTED

By Members of the Catholic University of Ireland.

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THE object of the work, which these lines are intended to introduce to the public, is to serve principally as the repository and memorial of such investigations in Literature and Science, as are made by the members of the new Catholic University of Ireland. It is natural that men, whose occupations are of an intellectual nature, should be led to record the speculations or the conclusions in which their labours have issued; and that, having taken this step, they should consider it even as a duty which they owe to society, to communicate to others what they have thought it worth while to record. A periodical publication is the obvious mode of fulfilling that duty.

The prospects of their work are to be determined by its object and character. They cannot hope to interest the general reader; but from this very circumstance they are happily precluded from the chance of competition with those various ably-conducted periodicals which already possess the popular favour. They do not aspire to include Theology, as such, among the subjects to which their pages are to be devoted; but here again they have the compensation, that they will not be running the risk, in anything they publish, of provoking that most serious of

all rivalries, which is founded on a principle of duty. Thus they hope to take their place among such writers as are absolutely unable to stand in each other's way, because they are all employed upon a field where there is room for all, and supply a market which cannot be overstocked, in which no one's loss is another's gain, but the success of each is the benefit of all.

Accordingly, instead of fearing rivals in those who are engaged in similar pursuits, the Conductors of the *Atlantis* are secure of friends. In undertakings such as theirs, success, from the nature of the case, is another name for merit; and failure can only arise from causes traceable to themselves. If they are sanguine that they shall be able to answer to the profession which they make in the very fact of their commencing, it is because they trust they have the elementary qualifications of zeal, industry, and determination.

The work will be published half-yearly, on the first of January and the first of July. Each number will be divided into three portions, devoted respectively to Literature, Science, and Notices, Literary or Scientific, the number of pages in each portion varying with the number.

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A COURSE OF TWENTY-ONE LECTURES

ON THE MS. MATERIALS OF ANCIENT IRISH HISTORY,

Delivered in the Catholic University of Ireland during the Sessions of 1855–56.

BY

EUGENE CURRY, M.R.I.A.,

Professor of Irish Archæology and History in the University.

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THE

ATLANTIS.

Art. I.—The Mission of the Benedictine Order.

As the physical universe is sustained and carried on in dependence on certain centres of power and laws of operation, so the course of the social and political world, and of that great religious organization called the Catholic Church, is found to proceed for the most part from the presence or action of definite persons, places, events, and institutions, as the visible cause of the whole. There has been but one Judæa, one Greece, one Rome; one Homer, one Cicero; one Cæsar, one Constantine, one Charlemagne. And so, as regards Revelation, there has been one St. John the Divine, one Doctor of the Nations. Dogma runs along the line of Athanasius, Augustine, Thomas. The conversion of the heathen is ascribed, after the Apostles, to champions of the truth so few, that we may almost count them, as Martin, Patrick, Augustine, Boniface. Then there is St. Antony, the father of monachism; St. Jerome, the interpreter of Scripture; St. Chrysostom, the great preacher. Agency and influence of Persons

Education follows the same law: it has its history in the Church, and its doctors or patriarchs in that history. This is the subject on which we propose to make some remarks in the pages which follow, taking Education in its broadest and most general sense, as the work contemplated in the august command, "Go, teach all nations", and as more or less connected with civilization, social advance, the cultivation of learning, sacred and in Christian Civilization.

profane, and similar great facts, which are its historical interpretation.

Of three especially: The outline of what we have to say on the subject is simple enough; it is the filling up of details, which will demand diligence in the writer, and patience in the reader. There are three main periods, then, of ecclesiastical history,—the ancient, the medieval, and the modern; so far is plain: and there are three Religious Orders in those periods respectively, which succeed, one the other, on the public stage, and represent the teaching of the Catholic Church during the time of their ascendancy. The first period is that long series of centuries, during which society was breaking, or had broken up, and then slowly attempted its own re-construction; the second may be called the period of re-construction; and the third dates from the Reformation, when that peculiar movement of mind commenced, the issue of which is still to come. Now, St. Benedict is the Patriarch of the ancient world; St. Dominic of the medieval; and St. Ignatius of the modern. And in saying this, we are in no degree disrespectful to the Augustinians, Carmelites, Franciscans, and other great religious families, which might be named; for we are not reviewing the whole history of Christianity, but selecting a particular aspect of it.

Benedict, Dominic, Ignatius, with their respective characteristics, Perhaps as much as this will be granted to us without great hesitation. Next we proceed, after thus roughly mapping out our view of history, roughly to colour it, by way of contrasting these three patriarchs of Christian teaching with each other. To St. Benedict then, who may fairly be taken to represent the various families of monks before his time and those which sprang from him (for they are all pretty much of one school), to this great saint let us assign, for his discriminating badge, the Poetical; to St. Dominic, the Scientific; and to St. Ignatius, the Practical and Useful.

corresponding to their respective histories, These characteristics, which belong respectively to the works of the three great Masters, grow out of the circumstances under which they respectively entered upon them. Benedict, entrusted with his mission almost as a boy, infused into it the romance and simplicity of boyhood. Dominic, a man of forty-five, a graduate in theology, a priest and a canon, brought with him into religion the maturity and completeness of learning, which he had acquired in the schools. Ignatius, a man of the world

before his conversion, transmitted as a legacy to his disciples that knowledge of mankind which cannot be learned in cloisters. And thus the three several Orders were (so to say) begotten in Poetry, Science, and Good Sense.

And here another coincidence suggests itself. We have been giving these three attributes to the three Patriarchs severally, from a *bonâ fide* regard to their history, and without at all having any theory of philosophy in our eye. But, after having so described them, it certainly did strike us that we had unintentionally been illustrating a somewhat popular notion of the day, the like of which is attributed to authors, with whom we have as little sympathy as with any persons who can be named. According to these speculators, the life, whether of a race or of an individual of the great human family, is divided into three stages, each of which has its own ruling principle and characteristic. The youth makes his start in life, with "*hope* at the prow, and *fancy* at the helm"; he has nothing else but these to impel or direct him; he has not lived long enough to exercise his reason, or to gather in a store of facts; and, because he cannot do otherwise, he dwells in a world which he has created. He begins with illusions. Now, facts are external to him, but his reason is his own: of the two, then, it is easier for him to exercise his reason than to ascertain facts. Accordingly, his first mental revolution, when he discards the life of aspiration and affection, which has disappointed him, and the dreams of which he has been the sport and victim, is to embrace a life of logic: this then is his second stage,—the metaphysical. He acts now on a plan, thinks by system, is cautious about his middle terms, and trusts nothing but what takes a scientific form. His third stage is when he has made full trial of life; when he has found his theories break down under the weight of facts, and experience falsify his most promising calculations. Then the old man recognizes at length, that what he can taste, touch, and handle, is trustworthy, and nothing beyond it. Thus he runs through his three periods of Imagination, Reason, and Sense; and then he comes to an end, and is not;—a most impotent and melancholy conclusion.

calling to mind the theory of the "three stages of evolution",

We repeat, we have no sympathy in so heartless a view of life, and yet it seems to square with what we have been saying of the three great Patriarchs of Christian teaching. And certainly there is a truth in it, which gives

but with an essential difference.

it its plausibility. However, we are not concerned here to do more than to put our finger on the point at which we diverge from it, in what we have been saying and must say concerning them. It is true, then, that history, as viewed in these three saints, is, somewhat after the manner of the theory we have mentioned, a progress from poetry through science to practical sense or prudence; but then this important *proviso* has to be borne in mind at the same time, that what the Catholic Church once has had, she never has lost. She has never wept over, or been angry with, time gone and over. Instead of passing from one stage of life to another, she has carried her youth and middle age along with her, on to her latest time. She has not changed possessions, but accumulated them, and has brought out of her treasure-house, according to the occasion, things new and old. She did not lose Benedict by finding Dominic; and she has still both Benedict and Dominic at home, though she has become the mother of Ignatius. Imagination, Science, Prudence, all are good, and she has them all. Things incompatible in nature, coëxist in her; her prose is poetical on the one hand, and philosophical on the other.

Mission of St. Ignatius too luminous to be discussed.

Coming now to the historical proof of the contrast we have been instituting, we are sanguine in thinking that one branch of it is already allowed by the consent of the world, and is undeniable. By common consent, the palm of Prudence, in the full sense of that comprehensive word, belongs to the School of Religion, of which St. Ignatius is the Founder. That great Society is the classical seat and fountain of discretion, practical sense, and wise government. Sublimer conceptions or more profound speculations may have been elaborated elsewhere; but, whether we consider the illustrious Body in its own constitution, or in its rules for instruction and direction, we see that it is its very genius to prefer this most excellent prudence to every other gift, and to think little both of poetry and of science, unless they happen to be useful. It is true that, in the long catalogue of its members, there are to be found the names of the most consummate theologians, and of scholars the most elegant and accomplished; but we are speaking here, not of individuals, but of the body itself. It is plain, that the body is not over-jealous about its theological traditions; or it certainly would not suffer Suarez to controvert with Molina, Viva with Vasquez, Passaglia with Petavius, and Faure with Suarez, de Lugo, and

Valentia. In this intellectual freedom its members justly glory; inasmuch as they have set their affections, not on the opinions of the Schools, but on the souls of men. And it is the same charitable motive, which makes them give up the poetry of life, the poetry of ceremonies,—of the cowl, the cloister, and the choir,—content with the most prosaic architecture, if it be but convenient, and the most prosaic neighbourhood, if it be but populous. We need not then dwell longer on this wonderful Religion, but may confine the remarks which are to follow, to the two Religions, which historically preceded it—the Benedictine and the Dominican.

Three Hebrew Patriarchs.

One preliminary more, suggested by a purely fanciful analogy:—As there are three great Patriarchs on the high road and public thoroughfare of Christian History, so there were three chief Patriarchs in the first age of the chosen people. Putting aside Noe and Melchisedec, and Joseph and his brethren, we recognize three venerable fathers,—Abraham, Isaac, and Jacob: Abraham, the father of many nations; Isaac the intellectual, living in solitary simplicity, and in loving contemplation; and Jacob, the persecuted and helpless, visited by marvellous providences, driven from place to place, set down and taken up again, illtreated by those who were his debtors, and maligned when he is innocent, yet carried on and triumphing amid all troubles by means of his most faithful and powerful guardian-archangel. We are exempted, by what has gone before, from the duty of completing our parallel, in the instance of Jacob; but, as to Benedictines and Dominicans, we shall introduce them successively under the type, as it may be called, of Abraham and Isaac.

St. Benedict prolific in monastic congregations,

St. Benedict, like the great Hebrew Patriarch, was the "Father of many nations". He has been styled "the Patriarch of the West", a title which there are many reasons for ascribing to him. Not only was he the first to establish a perpetual Order of Regulars in Western Christendom; not only, as coming first, has he had an ampler course of centuries for the multiplication of his children; but his Rule, as that of St. Basil in the East, is the normal rule of the first ages of the Church, and was in time generally received even in communities which in no sense owed their origin to him. Moreover, out of his Order rose, in process of time, various new monastic families, which have established themselves as independent institutions, and are able

to boast in their turn of the number of their houses, and the sanctity and historical celebrity of their members. He is the representative of Latin monachism for the long extent of six centuries, while monachism was one; and even when at length varieties arose, and distinct titles were given to them, the change grew out of him;—not the act of strangers who were his rivals, but of his own children, who did but make a new beginning in all devotion and loyalty to him. He died in the early half of the sixth century; at the beginning of the tenth rose from among his French monasteries the famous Congregation of Cluni, illustrated by St. Majolus, St. Odilo, Peter the Venerable, and other considerable personages, among whom is Hildebrand, afterwards Pope Gregory the Seventh. Then came, in long succession, the Orders or Congregations of Camaldoli under St. Romuald, of Vallombrosa, of Citeaux, to which St. Bernard has given his name, of Monte Vergine, of Fontvrault; those of England, Spain, and Flanders; the Silvestrines, the Celestines, the Olivetans, the Humiliati, besides a multitude of institutes for women, as the Gilbertines and the Oblates of St. Frances, and then at length, to mention no others, the Congregation of St. Maur in modern times, so well known for its biblical, patristical, and historical works, and for its learned members, Montfaucon, Mabillon, and their companions. The panegyrists of this illustrious Order are accustomed to claim for it in all its branches as many as thirty-seven thousand houses, and, besides numerous Popes, 200 Cardinals, 4 Emperors, 46 Kings, 51 Queens, 1,406 Princes, 1,600 Archbishops, 600 Bishops, 2,400 Nobles, and 15,000 Abbots and learned men.[1]

and the adopted father of many more.

Nor are the religious bodies which sprang from St. Benedict the full measure of what he has accomplished,—as has been already observed. His Rule gradually made its way into those various monasteries, which were of an earlier or an independent foundation. It first coalesced with, and then supplanted, the Irish Rule of St. Columban in France, and the still older institutes which had been brought from the East by St. Athanasius, St. Eusebius, and St. Martin. At the beginning of the ninth century it was formally adopted throughout the dominions of Charlemagne. Pure, or with some admixture, it was

[1] Helyot, Hist. Mon. Ziegelbauer, Litt. Hist. Soame's Mosheim, vol. ii, p. 26. Buckingham's Bible in the Middle Ages, p. 81, etc., etc.

brought by St. Augustine to England; and that admixture, if it existed, was gradually eliminated by St. Wilfrid, St. Dunstan, and Lanfranc, till at length it was received, with the name and obedience of St. Benedict, in all the Cathedral monasteries[2] (to make no mention of others), excepting Carlisle. Nor did it cost such regular bodies any very great effort to make the change, even when historically most separate from St. Benedict; for the Saint had taken up for the most part what he found, and his Rule was but the expression of the genius of monachism in those first ages of the Church, with a more exact adaptation to their needs, than could elsewhere be found.

Recognizes the unity of the monastic idea.

So uniform indeed had been the monastic idea before his time, and so little stress had been laid by individual communities on their respective peculiarities, that religious men passed at pleasure from one body to another.[3] St. Benedict provides in his Rule for the case of strangers coming to one of his houses, and wishing to remain there. If such a one came from any monastery with which the monks had existing relations, then he was not to be received without letters from his Abbot; but, in the instance of "a foreign monk from distant parts", who wished to dwell with them as a guest, and was content with their ways, and conformed himself to them, and was not troublesome, "should he in the event wish to stay for good", says St. Benedict, "let him not be refused; for there has been room to make trial of him, during the time that hospitality has been shown him: nay, let him even be invited to stay, that others may gain a lesson from his example; for in every place we are servants of one Lord and soldiers of one King".[4]

Monastic unity in contrast to the multiform world.

The unity, which these words imply as the distinctive token of a monk in every part of Christendom, may be described as a unity of object, of state, and of occupation. Monachism was one and the same everywhere, because it was a reaction from that secular life, which has everywhere the same structure and the same characteristics. And, since that secular life contained in it many objects, many states, and many occupations, here was a special reason, as a matter of principle, why the reaction from it should

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[2] Butler, June 22.
[3] Thomassin, Disc. Eccl., t. i., p. 705. Calmet, Reg. Ben., t. ii., p. 25. Mabillon, Acta Sæc., iv., p. 1. præf., p. xxx. Annal., t. i., præf., § 19.
[4] Reg., c. 61.

bear the badge of unity, and should be in outward appearance one and the same everywhere. Moreover, since that same secular life was, when monachism arose, more than ordinarily marked by variety, perturbation, and confusion, it seemed on that very account to justify emphatically a rising and revolt against itself, and a recurrence to some state, which, unlike itself, was constant and unalterable. It was indeed an old, decayed, and moribund world, into which Christianity had been cast. The social fabric was overgrown with the corruptions of a thousand years, and was held together, not so much by any common principle, as by the strength of possession and the tenacity of custom. It was too large for public spirit, and too artificial for patriotism, and its many religions did but foster in the popular mind division and scepticism. Want of mutual confidence would lead to despondency, inactivity, and selfishness. Society was in the slow fever of consumption, which made it restless in proportion as it was feeble. It was powerful, however, to seduce and deprave; nor was there any *locus standi* from which to combat its evils; and the only way of getting on with it was to abandon principle and duty, to take things as they came, and to do as the world did. Worse than all, this encompassing, entangling system of things, was, at the time we speak of, the seat and instrument of a paganism, and then of heresies, not simply contrary, but bitterly hostile, to the Christian name. Serious men not only had a call, but every inducement which love of life and freedom could inspire, to escape from its presence and its sway.

The principle of monastic unity

Their one idea then, their one purpose, was to be quit of it; too long had it enthralled them. It was not a question of this or that vocation, of the better deed, of the higher state, but of life and death. In other times a variety of holy objects might present themselves for devotion to choose from, such as the care of the poor, or of the sick, or of the young, the redemption of captives, or the conversion of the barbarians; but early monachism was flight from the world, and nothing else. The troubled, jaded, weary heart, the stricken, laden conscience, sought a life free from corruption in its daily work, free from distraction in its daily worship; and it sought employments, as contrary as possible to the world's employments,—employments, the end of which would be in themselves, in which each day, each hour, would have its own completeness;—no elaborate undertakings, no difficult aims, no anxious ven-

tures, no uncertainties to make the heart beat, or the temples throb, no painful combination of efforts, no extended plan of operations, no multiplicity of details, no deep calculations, no sustained machinations, no suspense, no vicissitudes, no moments of crisis or catastrophe;—nor again any subtle investigations, nor perplexities of proof, nor conflicts of rival intellects, to agitate, harass, depress, stimulate, weary, or intoxicate the soul.

was renunciation of the world, of the senses and reason,

Hitherto we have been using negatives to describe what the primitive monk was seeking; in truth monachism was, as regards the secular life and all that it implies, emphatically a negation, or, to use another word, a *mortification;* a mortification of sense, and a mortification of reason. Here a word of explanation is necessary. The monks were too good Catholics to deny that reason was a divine gift, and had too much common sense to think to do without it. What they denied themselves was the various and manifold exercises of the reason; and on this account, because such exercises were excitements. When the reason is cultivated, it at once begins to combine, to centralize, to look forward, to look back, to view things as a whole, whether for speculation or for action; it practises synthesis and analysis, it discovers, it invents. To these exercises of the intellect is opposed simplicity, which is the state of mind which does not combine, does not deal with premisses and conclusions, does not recognize means and their end, but lets each work, each place, each occurrence stand by itself,—which acts towards each as it comes before it, without a thought of anything else. This simplicity is the temper of children, and it is the temper of monks. This was their mortification of the intellect; every man who lives, must live by reason, as every one must live by sense; but, as it is possible to be content with the bare necessities of animal life, so is it possible to confine ourselves to the bare ordinary use of reason, without caring to improve it or make the most of it. These monks held both sense and reason to be the gifts of heaven, but they used each of them as little as they could help, reserving their full time and their whole selves for devotion;—for, if reason is better than sense, so devotion they thought to be better than either; and, as even a heathen might deny himself the innocent indulgences of sense in order to give his time to the cultivation of the reason, so did the monks give up reason, as well as sense, that they might consecrate themselves to divine meditation.

with rest, retirement, simplicity of life.

Now, then, we are able to understand how it was that the monks had a unity, and in what it consisted. It was a unity, we have said, of object, of state, and of occupation. Their object was rest and peace; their state was retirement; their occupation was some work that was simple, as opposed to intellectual, viz., prayer, fasting, meditation, study, transcription, manual labour, and other unexciting, soothing employments. Such was their institution all over the world; they had eschewed the busy mart, the craft of gain, the money-changer's bench, and the merchant's cargo. They had turned their backs upon the wrangling forum, the political assembly, and the pantechnicon of trades. They had had their last dealings with architect and habit-maker, with butcher and cook; all they wanted, all they desired, was the sweet soothing presence of earth, sky, and sea, the hospitable cave, the bright running stream, the easy gifts, which mother earth, "justissima tellus", yields on very little persuasion. "The monastic institute", says the biographer of St. Maurus, "*demands the most perfect quietness*";[5] and where was quietness to be found, if not in reverting to the original condition of man, as far as the changed circumstances of our race admitted, in having no wants, of which the supply was not close at hand; in the "nil admirari"; in having neither hope nor fear of anything below; in daily prayer, daily bread, and daily work, one day being just like another, except that it was one step nearer than the day before it, to that great Day, which would swallow up all days, the day of everlasting rest?

The Summa quies.

M. Guizot's distinction between Eastern and Western monks

However, we have come into collision with a great authority, M. Guizot, and we must stop the course of our argument to make our ground good against him. M. Guizot, then, makes a distinction between monachism in its birth-place, in Egypt and Syria, and that Western institute, of which we have made St. Benedict the representative. He allows that the Orientals mortified the intellect, but he considers that Latin monachism was the seat of considerable mental activity. "The desire for retirement", he says, "for contemplation, for a marked rupture with civilized society, was the source and fundamental trait of the eastern monks: in the West, *on the contrary*, and especially in Southern Gaul, where, at the commencement of the fifth century, the principal monasteries

[5] Mabillon, Act. Benedict., t. iv., p. 1, p. xxxvii.

were founded, it was in order to live in common, ***with a view to conversation*** as well as to religious edification, that the first monks met. The monasteries of Lerins, of St. Victor, and many others, were especially great schools of theology, the focus of intellectual movement. It was by no means with solitude or with mortification, but with discussion and activity, that they there concerned themselves".[6] Great deference is due to an author so learned, so philosophical, so honestly desirous to set out Christianity to the best advantage; yet, we are at a loss to understand what has led him to make such a distinction between the East and West, and to assign to the Western monks an activity of intellect, and to the Eastern a love of retirement. **untenable;**

It is quite true that instances are sometimes to be found of monasteries in the West, distinguished by much intellectual activity, but more, and more striking, instances are to be found of a like phenomenon in the East. If, then, such particular instances are to be taken as fair specimens of the state of Western monachism, they are equally fair specimens of the state of Eastern also; and the Eastern monks will be proved more intellectual than the Western, by virtue of that greater interest in doctrine and in controversy which given individuals or communities among them have exhibited. A very cursory reference to ecclesiastical history will be sufficient to show us, that the fact is as we have stated it. The theological sensitiveness of the monks of Marseilles, Lerins, or Adrumetum, it seems, is to be a proof of the intellectualism generally of the West: then, why is not the greater sensitiveness of the Scythian monks at Constantinople, and of their opponents the Accemetæ, an evidence in favour of the East? These two bodies of Religious actually came all the way from Constantinople to Rome to denounce one another, besieging, as it were, the Holy See, and the former of them actually attempting to raise the Roman populace against the Pope, in behalf of its own theological tenet. Does not this show activity of mind? We venture to say, that, for one intellectual monk in the West, a dozen might be produced in the East. The very reproach, so freely thrown out by secular historians against the Greeks, of over-subtlety of intellect, applies, if to any men, to certain classes or certain communities of Eastern monks. Some- **not only unfounded,** **but contrary to fact,**

[6] History of Civilization, vol. ii., p. 65. Bohn.

times they were enthusiastically orthodox, quite as often furiously heretical. If Pelagius be a monk in the West, on the other hand, Nestorius and Eutyches, both heresiarchs, are both monks in the East; and Eutyches, at the time of his heresy, was an old monk into the bargain, who had been thirty years abbot of a convent, and whom age, if not sanctity, might have saved from this abnormal use of his reason. His partizans were principally monks of Egypt; and they, coming up in force to the pseudo-synod of Ephesus, kicked to death the patriarch of Constantinople, and put to flight the Legate of the Pope, and all this out of a keen susceptibility about an intellectual opinion. A century earlier, Arius, on starting, carried away into his heresy as many as seven hundred nuns;[7] what have the Western convents to show, in the way of controversial activity, comparable with a fact like this? We do not insist on the zealous and influential orthodoxy of the monks of Egypt, Syria, and Asia Minor in the fourth century, because it was probably nothing else but an honourable adhesion to the faith of the Church; but turn to the great writers of Eastern Christendom, and consider how many of them at first sight are monks;—Chrysostom, Basil, Gregory Nazianzen, Epiphanius, Ephrem, Amphilochius, Isidore of Pelusium, Theodore, Theodoret, perhaps Athanasius. Among the Latin writers no names occur to us but those of Jerome and Pope Gregory; we may add Paulinus, Sulpicius, and Cassian, but Jerome is the only learned writer among them. We have a difficulty, then, even in comprehending, not to speak of admitting, M. Guizot's assertion, a writer who does not commonly speak without a meaning or a reason.

as regards Convents, and as regards Fathers.

But, after all, however the balance of intellectualism may lie between certain convents or individuals in the East and the West, such particular instances are nothing to the purpose, when taken to measure the state of the great body of the monks; certainly not in the West, with which in this paper we are exclusively concerned. In taking an estimate of the Benedictines, we need not trouble ourselves about the state of monachism in Egypt, Syria, Asia Minor, and Constantinople, at least after the fourth century, by the end of which time the tradition had passed from the East to the West. Now, the Eastern Monks of the fourth century simply follow the defined and promul-

Intellectualism of Eastern monks inconsistent with their tradition.

[7] Epiph. Hær., 69.

gated doctrine of the Church; their intellectualism proper begins with the fifth. Taking, then, the great tradition of St. Antony, St. Pachomius, and St. Basil in the East, and tracing it into the West by the hands of St. Athanasius, St. Martin, and their contemporaries, we shall find no historical facts but what admit of a fair explanation, consistent with the views which we have laid down above about monastic simplicity, bearing in mind always, what holds in all matters of fact, that there never was a rule without its exceptions.

Intellectual and political monks of the West, individual exceptions.

Every rule has its exceptions; but, further than this, when exceptions occur, they are likely to be great ones. This is no paradox; illustrations of it are to be found every where. For instance, we may conceive a climate very fatal to children, and yet those who escape growing up to be strong men; and for a plain reason, because those alone could have passed the ordeal who had robust constitutions. Thus the Romans, so jealous of their freedom, when they resolved on the appointment of a supreme ruler for an occasion, did not do the thing by halves, but made him a Dictator. In like manner, a trifling occurrence, or an ordinary inward impulse, will be powerless to snap the bond which keeps the monk fast to his cell, his oratory, and his garden. Exceptions, indeed, may be few, because they *are* exceptions, but they will be great. It must be a serious emergence, a particular inspiration, a sovereign command, which brings the monk into political life; and he will be sure to make a great figure in it, else why should he have been torn from his cloister at all? This will account for the career of St. Gregory the Seventh or of St. Dunstan, of St. Bernard or of Abbot Suger, as far as it was political: the work they had to do was such, as none could have done but a monk with his superhuman single-mindedness and his pertinacity of purpose. Again, in the case of St. Boniface, the Apostle of Germany, and in that of others of the missionaries of his age, it seems to have been a particular inspiration which carried them abroad; and it is observable after all how soon most of them settled down into the mixed character of agriculturists and pastors in their new country, and resumed the tranquil life to which they had originally devoted themselves.

And originally in the East also.

As to the early Greek Fathers, some of those whom we have instanced above are only *primâ facie* exceptions, as Chrysostom, who, though he lived with the monks most austerely for as many as six years,

can hardly be said to have taken on himself the responsibilities of their condition, or to have simply abandoned the world. Others of them, as Basil, were scholars, philosophers, men of the world, before they were monks, and could not put off their cultivation of mind or their learning with their secular dress; and these would be the very men, in an age when such talents were scarce, who would be taken out of their retirement by superior authority, and who therefore cannot fairly be quoted as ordinary specimens of the monastic life.

As illustrated in St. Basil,

Exceptio probat regulam: let us see what two Doctors of the Church, one Greek, one Latin, both rulers, both monks, say concerning the state, which they at one time enjoyed, and afterwards lost. "You tell me", says St. Basil, writing to a friend from his solitude, "that it was little for me to describe the place of my retirement, unless I mentioned also my habits and my mode of life; yet really I am ashamed to tell you how I pass night and day in this lonely nook. I am like one, who is angry with the size of his vessel, as tossing overmuch, and leaves it for the boat, and is seasick and miserable still. However, what I propose to do is as follows, with the hope of tracing His steps who has said, 'If any one will come after Me, let him deny himself'. We must strive after a quiet mind. As well might the eye ascertain an object which is before it, while it roves up and down without looking steadily at it, as a mind, distracted with a thousand worldly cares, be able clearly to apprehend the truth. One who is not yoked in matrimony, is harassed by rebellious impulses and hopeless attachments; he who is married, is involved in his own tumult of cares: is he without children? he covets them; has he children? he has anxieties about their education. Then there is solicitude about his life, care of his house, oversight of his servants, misfortunes in trade, differences with his neighbours, lawsuits, the merchant's risks, the farmer's toil. Each day, as it comes, darkens the soul in its own way; and night after night takes up the day's anxieties, and cheats us with corresponding dreams. Now, the only way of escaping all this is separation from the whole world, so as to live without city, home, goods, society, possessions, means of life, business, engagements, secular learning, that the heart may be prepared as wax for the impress of divine teaching. Solitude is of the greatest use for this purpose, as it stills our passions, and enables

reason to extirpate them. Let then a place be found, such as mine, separate from intercourse with men, that the tenor of our exercises be not interrupted from without. Pious exercises nourish the soul with divine thoughts. Soothing hymns compose the mind to a cheerful and calm state. Quiet, then, as I have said, is the first step in our sanctification; the tongue purified from the gossip of the world, the eyes unexcited by fair colour or comely shape, the ear secured from the relaxation of voluptuous songs, and that especial mischief, light jesting. Thus, the mind, rescued from dissipation from without, and sensible allurements, falls back upon itself, and thence ascends to the contemplation of God".[8] It is quite clear that at least St. Basil took the same view of the monastic state as we have done.

So much for the East in the fourth century; now for the West in the seventh. "One day", says St. Gregory, after he had been constrained, against his own wish, to leave his cloister for the government of the Universal Church, "one day, when I was oppressed with the excessive trouble of secular affairs, I sought a retired place, friendly to grief, where whatever displeased me in my occupations might show itself, and all that was wont to inflict pain might be seen at one view". While he was in this retreat, his most dear son, Peter, with whom, since the latter was a youth, he had been intimate, surprised him, and he opened his grief to him. "My sad mind", he said, "labouring under the soreness of its engagements, remembers how it went with me formerly in this monastery, how all perishable things were beneath it, how it rose above all that was transitory, and, though still in the flesh, went out in contemplation beyond that prison, so that it even loved death, which is commonly thought a punishment, as the gate of life and the reward of labour. But now, in consequence of the pastoral charge, it undergoes the busy work of secular men, and for that fair beauty of its quiet, is dishonoured with the dust of the earth. And often dissipating itself in outward things, to serve the many, even when it seeks what is inward, it comes home indeed, but is no longer what it used to be".[9] Here is the very same view of the monastic state at Rome, which St. Basil had in Pontus, viz., retirement and repose. There have been great Religious Orders since, whose at-

and in St. Gregory, Pope.

[8] Ep. 2. [9] Dial., i. 1.

mosphere has been conflict, and who have thriven in smiting or in being smitten. It has been their high calling; it has been their peculiar meritorious service; but, as for the Benedictine, the very air he breathes is peace.

Monachism aimed at the golden age,

We have now said enough both to explain and to vindicate the biographer of St. Maurus, when he says that the object, and life, and reward of the ancient monachism is "summa quies",—the absence of all excitement, sensible and intellectual, and the vision of Eternity. And therefore have we called the monastic state the most poetical of religious disciplines. It was a return to that primitive age of the world, of which poets have so often sung, the simplicity of Arcadia or the reign of Saturn, when fraud and violence were unknown. It was a bringing back of those real, not fabulous, scenes of innocence and miracle, when Adam delved, or Abel kept sheep, or Noe planted the vine, and Angels visited them. It was a fulfilment in the letter, of the glowing imagery of prophets, about the evangelical period. Nature for art, the wide earth and majestic heavens for the crowded city, the subdued and docile beasts of the field for the wild passions and rivalries of social life, tranquillity for ambition and care, divine meditation for the exploits of the intellect, the Creator for the creature, such was the normal condition of the monk. He had tried the world, and found its hollowness; or he had eluded its fellowship, before it had solicited him;—and so St. Antony fled to the desert, and St. Hilarion sought the sea shore, and St. Basil ascended the mountain ravine, and St. Benedict took refuge in his cave, and St. Giles buried himself in the forest, and St. Martin chose the broad river, in order that the world might be shut out of view, and the soul might be at rest. And such a rest of intellect and of passion as this is full of the elements of the poetical.

and therefore was poetical.

We have no intention of committing ourselves here to a definition of poetry; we may be thought wrong in the use of the term; but, if we explain what we mean by it, no harm is done, whatever be our inaccuracy, and each reader may substitute for it some word he likes better. Poetry, then, we conceive, whatever be its metaphysical essence, or however various may be its kinds, whether it more properly belongs to action or to suffering, nay, whether it is more at home with society or with nature, whether its spirit is seen to best advantage in Homer or in Virgil, at any rate, is always the antagonist to *science*. As science

makes progress in any subject matter, poetry recedes from it. The two cannot stand together; they belong respectively to two modes of viewing things, which are contradictory of each other. Reason investigates, analyses, numbers, weighs, measures, ascertains, locates, the objects of its contemplation, and thus gains a scientific knowledge of them. Science results in system, which is complex unity; poetry delights in the indefinite and various as contrasted with unity, and in the simple as contrasted with system. The aim of science is to get a hold of things, to grasp them, to handle them, to comprehend them; that is (to use the familiar term), to *master* them, or to be superior to them. Its success lies in being able to draw a line round them, and to tell where each of them is to be found within that circumference, and how each lies relatively to all the rest. Its mission is to destroy ignorance, doubt, surmise, suspense, illusions, fears, deceits, according to the "Felix qui potuit rerum cognoscere causas" of the Poet, whose whole passage, by the way, may be taken as drawing out the contrast between the poetical and the scientific.[10] But as to the poetical, very different is the frame of mind, which is necessary for its perception. It demands, as its primary condition, that we should not put ourselves above the objects in which it resides, but at their feet; that we should feel them to be above and beyond us, that we should look up to them, and that, instead of fancying that we can comprehend them, we should take for granted that we are surrounded and comprehended by them ourselves. It implies that we understand them to be vast, immeasurable, impenetrable, inscrutable, mysterious; so that at best we are only forming conjectures about them, not conclusions, for the phenomena which they present admit of many explanations, and we cannot know the true one. Poetry does not address the reason, but the imagination and affections; it leads to

Poetry as opposed to Science,

as Imagination to Reason:

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[10] Me verò primùm dulces ante omnia Musæ . . .
Accipiant, *cœlique vias et sidera monstrent*, etc., etc.
Sin, has ne possim naturæ accedere partes,
Frigidus obstiterit circùm præcordia sanguis,
Rura mihi et rigui placeant in vallibus amnes, etc.

And so again:

Felix, qui potuit rerum cognoscere *causas*, etc.
Fortunatus et ille, Deos qui novit agrestes, etc.

admiration, enthusiasm, devotion, love. The vague, the uncertain, the irregular, the sudden, are among its attributes or sources. Hence it is that a child's mind is so full of poetry, because he knows so little; and an old man of the world so devoid of poetry, because his experience of facts is so wide. Hence it is that nature is commonly more poetical than art, in spite of Lord Byron, because it is less comprehensible and less patient of definitions; history more poetical than philosophy; the savage than the citizen; the knight errant than the brigadier-general; the winding bridle path than the straight railroad; the sailing vessel than the steamer; the ruin than the spruce suburban box; the Turkish robe or Spanish doublet than the French dress coat. We have said far more than enough to make it clear what we mean by that element in the old monastic life, to which we have given the name of the Poetical.

exemplified in the history, and constitution,

Now, in many ways the family of St. Benedict answers to this description, as we shall see if we look into its history. Its spirit indeed is ever one, but not its outward circumstances. It is not an Order proceeding from one mind at a particular date, and appearing all at once in its full perfection, and in its extreme development, and in form one and the same everywhere, and from first to last, as is the case with other great religious institutions; but it is an organization, diverse, complex, and irregular, and variously ramified, rich rather than symmetrical, with many origins and centres and new beginnings and the action of local influences, like some great natural growth; with tokens, on the face of it, of its being a divine work, not the mere creation of human genius. Instead of progressing on plan and system and from the will of a superior, it has shot forth and run out as if spontaneously, and has shaped itself according to events, from an irrepressible fulness of life within, and from the energetic self-action of its parts, like those symbolical creatures in the prophet's vision, which "went every one of them straight forward, whither the impulse of the spirit was to go". It has been poured out over the earth, rather than been sent, with a silent mysterious operation, while men slept, and through the romantic adventures of individuals, which are well nigh without record; and thus it has come down to us, not risen up among us, and is found rather than established. Its separate and scattered monasteries occupy the land, each in its place, with a majesty parallel, but superior, to

that of old aristocratic houses. Their known antiquity, their unknown origin, their long eventful history, their connection with Saints and Doctors when on earth, the legends which hang about them, their rival ancestral honours, their extended sway, perhaps, over other religious houses, their hold upon the associations of the neighbourhood, their traditional friendships and compacts with other great landlords, the benefits they have conferred, the sanctity which they breathe, these and the like attributes make them objects, at once of awe and of affection.

and the social position of the Benedictines.

Such is the great Abbey of Bobio, in the Apennines, where St. Columban came to die, having issued with his twelve monks from his convent in Benchor, county Down, and having spent his life in preaching godliness and planting monasteries in half-heathen France and Burgundy. Such St. Gall's, on the lake of Constance, so called from another Irishman, one of St. Columban's companions, who remained in Switzerland, when his master went on into Italy. Such the Abbey of Fulda, where lies St. Boniface, who, burning with zeal for the conversion of the Germans, attempted them a first time and failed, and then a second time and succeeded, and at length crowned the missionary labours of forty-five years with martyrdom. Such Monte Cassino, the metropolis of the Benedictine name, where the Saint broke the idol, and cut down the grove, of Apollo. Ancient houses such as these subdue the mind by the mingled grandeur and sweetness of their presence. They stand in history with an accumulated interest upon them, which belongs to no other monuments of the past. Whatever there is of venerable authority in other foundations, in Bishops' sees, in Cathedrals, in Colleges, respectively, is found in combination in them. Each gate and cloister has had its own story, and time has engraven upon their walls the chronicle of its revolutions. And, even when at length rudely destroyed, or crumbled into dust, they live in history and antiquarian works, in the pictures and relics which remain of them, and in the traditions of their place.

Examples in point.

In the early part of last century the Maurist Fathers, with a view of collecting materials for the celebrated works which they had then on hand, sent two of their number on a tour through France and the adjacent provinces. Among other districts the travellers passed through the forest of Ardennes, which has been made classical by the prose of Cæ-

The particular example of St. Hubert's Abbey.

sar, and the poetry of Shakespeare. There they found the great Benedictine Convent of St. Hubert;[11] and, if we dwell awhile upon the illustration which it affords of what we have been saying, it is not as if twenty other religious houses which they visited would not serve our purpose quite as well, but because it has come first to our hand in turning over the pages of their volume. At that time the venerable abbey in question had upon it the weight of a thousand years, and was eminent above others in the country in wealth, in privileges, in name, and, not the least recommendation, in the sanctity of its members. The lands, on which it was situated, were its freehold, and their range included sixteen villages. The old chronicle informs us, that, about the middle of the seventh century, *Founded in Ardennes* St. Sigibert, the Merovingian, pitched upon Ardennes and its neighbourhood for the establishment of as many as twelve monasteries, with the hope of thereby obtaining from heaven an heir to his crown. Dying prematurely, he but partially fulfilled his pious intention, which was taken up by Pepin, sixty years afterwards, at the instance of his chaplain, St. Beregise; so far, at least, as to make a com- *in first years of 8th century,* mencement of the abbey of which we are speaking. Beregise had been a monk of the Benedictine Abbey of St. Tron, and he chose for its site a spot in the midst of the forest, marked by the ruins of a temple dedicated to the pagan Diana, the goddess of the chase. The holy man exorcised the place with the sign of the Cross; and, becoming abbot of the new house, filled it either with monks, or as seems less likely, with secular canons. From that *visited in 18th by Maurists,* time to the summer day, when the two Maurists visited it, the sacred foundation, with various fortunes, had been in possession of the land.

On entering its precincts, they found it at once full and empty: empty of the monks, who were in the fields ga- *reformed in the 17th* thering in the harvest; full of pilgrims, who were wont to come day after day, in neverfailing succession, to visit the tomb of St. Hubert. What a series of events has to be recorded to make this simple account intelligible! and how poetical is the picture which it sets before us, as well as those events themselves, which it presupposes, when they come to be detailed! Were it not that we should be

[11] Voyage Littéraire. Vid. also Calmet, Lorraine, t. i., p. 1043. Moreri, art. S. Hubert. Gallia Christ., t. iii., p. 966. Mabillon, Annal. Bened., t. ii., pp. 16, 441, 606. Bucherii, Gest. Tungr. etc., t. i., p. 153. Helyot, Ordres Mon., t vi., p. 296.

swelling a passing illustration into a history, we might go on to tell how strict the observance of the monks had been for the last hundred years before the travellers arrived there, since Abbot Nicholas de Fanson had effected a reform on the pattern of the French Congregation of St. Vanne. We might relate how, when a simple monk in the Abbey of St. Hubert, Nicholas had wished to change it for a stricter community, and how he got leave to go off to the Congregation just mentioned, and how then his old Abbot died suddenly, and how he himself to his surprise was elected in his place. And we might tell how, when his mitre was on his head, he set about reforming the house which he had been on the point of quitting, and how he introduced for that purpose two monks of St. Vanne; and how the Bishop of Liege, in whose diocese he was, set himself against his holy design, and how some of the old monks attempted to poison him; and how, though he carried it into effect, still he was not allowed to aggregate his Abbey to the Congregation whose reform he had adopted; and how his good example encouraged the neighbouring abbeys to commence a reform in themselves, which issued in an ecclesiastical union of the Flemish Benedictines.

according to the reform of St. Vanne,

All this, however, would not have been more than one passage, of course, in the adventures which had befallen the abbey and its abbots in the course of its history. It had had many seasons of decay before the time of Nicholas de Fanson, and many restorations, and from different quarters. None of them was so famous or important as the reform effected in the year 817, about a century after its original foundation, when the secular canons were put out, and the monks put in, at the instance of the then Bishop of Liege, who had a better spirit than his successor in the time of Nicholas. The new inmates were joined by some persons of noble birth from the Cathedral, and by their suggestion and influence the bold measure was taken of attempting to gain from Liege the body of the great St. Hubert, the Apostle of Ardennes. Great, we may be sure, was the resistance of the city where he lay; but Abbot Alreus, the friend and fellow-workman of St. Benedict of Anian, the first Reformer of the Order before the date of Cluni, went to the Bishop, and he went to the Archbishop of Cologne; and then both prelates went to the Emperor Louis le Debonnaire, the son of Charlemagne, whose favourite hunting ground the forest was; and he referred the matter to the great Council of Aix-la-Chapelle, whence a

reformed in the 9th,

and presented with St. Hubert's body,

decision came in favour of the monks of Ardennes. So with great solemnity the sacred body was conveyed by water to its new destination; and there in the Treasury, in memorial of the happy event, the Maurist visitors saw the very chalice of gold, and the beautiful copy of the Gospels, ornamented with precious stones, given to the Abbey by Louis at the time. Doubtless it was the handiwork of the monks of some other Benedictine House, as must have been the famous Psalter, of which the visitors speak also, written in letters of gold, the gift of Louis's son, the Emperor Lothaire; and there he sits in the first page, with his crown on his head, his sceptre in one hand, his sheathed sword in the other, and something very like a fleur-de-lys buckling on his ermine robe at the shoulder:—which precious gift, that is, the Psalter with all its pictures, two centuries after came most unaccountably into the possession of the Lady Helvidia of Aspurg, who gave it to her young son Bruno, afterwards Pope Leo the Ninth, to learn the Psalms by; but, as the young Saint made no progress in his task, she came to the conclusion that she had no right to the book, and so she ended by making a pilgrimage to St. Hubert with Bruno, and, not only gave back the Psalter, but made the offering of a Sacramentary besides.

and with illuminated MSS.

But to return to the relics of the Saint; the sacred body was taken by water up the Maes. The coffin was of marble, and perhaps could have been taken no other way; but another reason, besides its weight, lay in the indignation of the citizens of Liege, who made several attempts, in the following years, to regain the body. In consequence, the good monks of Ardennes hid it within the walls of their monastery, confiding the secret of its whereabouts to only two of their community at a time; and they showed in the sacristy to the devout, instead, the Saint's ivory cross and his stole, the sole of his shoe and his comb, and Diana, Marchioness of Autrech, gave a golden box to hold the stole. This, however, was in after times; for they were very loth at first to let strangers within their cloisters at all; and in 838, when a long spell of rain was destroying the crops, and the people of the neighbourhood came in procession to the shrine to ask the intercession of the Saint, the cautious Abbot Sewold, availing himself of the Rule, would only admit priests, and them by threes and fours, with naked feet, and a few laymen with each of them. The supplicants were good men, however, and had no

The saint's body concealed,

but visited in devotion.

notion of playing any trick: they came in piety and devotion, and the rain ceased, and the country was the gainer by St. Hubert of Ardennes. And thenceforth others, besides the monks, became interested in his stay in the forest.

And now we have said something in explanation, why the courtyard was full of pilgrims, when the travellers came. St. Hubert had been an object of devotion for a particular benefit, perhaps ever since he came there, certainly as early as the eleventh century, for we then have historical notice of it. His preference of the forest to the city, which he had shown in life before his conversion, was illustrated by the particular grace or miraculous service, for which, more than for any other, he used his glorious intercession on high. He is famous for curing those who had suffered from the bite of wild animals, especially dogs of the chase, and a hospital was attached to the Abbey for their reception. The sacristan of the Church officiated in the cure; and with rites which never indeed failed, but which to some cautious persons seemed to savour of superstition. Certainly they were startling at first sight; accordingly a formal charge on that score was at one time brought against them before the Bishop of Liege, and a process followed. The Bishop, the University of Louvain, and its Faculty of Medicine, conducted the inquiry, which was given in favour of the Abbey, on the ground that what looked like a charm might be of the nature of a medical regimen.

Famous for cures of bites.

However, though the sacristan was the medium of the cure, the general care of the patients was left to externs. The hospital was served by secular priests, since the monks heard no confessions save those of their own people. This rule they observed, in order to reserve themselves to the proper duties of a Benedictine,—the choir, study, manual labour, and transcription of books; and, while the Maurists were ocular witnesses of their agricultural toils, they saw the diligence of their penmanship in its results, for the MSS. of their Library were the choicest in the country. Among them, they tell us, were copies of St. Jerome's Bible, the Acts of the Councils, Bede's History, Gregory and Isidore, Origen and Augustine.

Hospital for the patients.

Library of choice MSS.

The Maurists report as favourably of the monastic buildings themselves, as of the hospital and library. Those buildings were a chronicle of past times, and of the changes which had taken place in them. First there were the poor

Monastic buildings,

huts of St. Beregise upon the half-cleared and still marshy ground of the forest; then came the rebuilding, when St. Hubert was brought there; and centuries after that, St. Thierry, the intimate friend of the great Pope Hildebrand, had renewed it magnificently, at the time that he was Abbot. He was sadly treated in his lifetime by his monks, as Nicholas after him; but, after his death, they found out that he was a Saint, which they might have discovered before it; and they placed him in the crypt, and there he and another holy Abbot after him lay in peace, till the Calvinists broke into it in the sixteenth century, and burned both of them to ashes. There were marks too of the same fanatics on the pillars of the nave of the Church; which had been built by Abbot John de Wahart in the twelfth century, and then again from its foundations by Abbots Nicholas de Malaise and Romaclus, the friend of Blosius, four centuries later; and it was ornamented by Abbot Cyprian, who was called the friend of the poor; and doubtless the travellers admired the marble of the choir and sanctuary, and the silver candelabra of the altar given by the reigning Lord Abbot; and perhaps they heard him sing solemn Mass on the Assumption, as was usual on that feast, with his four secular chaplains, one to carry his Cross, another his mitre, a third his gremial, and a fourth his candle, and accompanied by the pealing organ and the many clattering bells, which had been the gift of Abbot Balla about a hundred years earlier. Can we imagine a more graceful union of human with divine, of the sweet with the austere, of business and of calm, of splendour and of simplicity, than is displayed in a great religious house after this pattern, when unrelaxed in its observance, and pursuing the ends for which it was endowed?

Church.

Magnificence of the abbot.

The Monks had been accused of choosing beautiful spots for their dwellings; as if this were a luxury in ascetics, and not rather the necessary alleviation of their penances. Even when their critics are kindest, they consider such sites as chosen by a sort of sentimental, ornamental indolence. "Beaulieu river", says Mr. Warner in his topography of Hampshire, and, as he writes far less illnaturedly than the run of authors, we will quote him, "Beaulieu river is stocked with plenty of fish, and boasts in particular of good oysters and fine plaice, and is fringed quite to the edge of the water with the most beautiful hanging woods. In the area enclosed are distinct traces of various fish-

The monks accused of choosing beautiful spots.

ponds, formed for the use of the convent. Some of them continue perfect to the present day, and abound with fish. A curious instance occurs also of monkish luxury, even in the article of water; to secure a fine spring those monastics have spared neither trouble nor expense. About half a mile to the south-east of the Abbey is a deep wood; and at a spot almost inaccessible is a cave formed of smooth stones. It has a very contracted entrance, but spreads gradually into a little apartment, of seven feet wide, ten deep, and about five high. This covers a copious and transparent spring of water, which, issuing from the mouth of the cave, is lost in a deep dell, and is there received, as I have been informed, by a chain of small stone pipes, which formerly, when perfect, conveyed it quite to the Abbey. It must be confessed, the monks in general displayed an elegant taste in the choice of their situations. Beaulieu Abbey is a striking proof of this. Perhaps few spots in the kingdom could have been pitched upon, better calculated for monastic seclusion than this. The deep woods, with which it is almost environed, throw an air of gloom and solemnity over the scene, well suited to excite religious emotions; while the stream that glides by its side, afforded to the recluse a striking emblem of human life: and at the same time that it soothed his mind by a gentle murmuring, led it to serious thought by its continual and irrevocable lesson".[12]

But they themselves made them beautiful.

The monks were not so soft as all this, after all; and if Mr. Warner had seen them, we feel sure he would have been astonished at the stern, as well as sweet simplicity which characterized them. They were not dreamy sentimentalists, to fall in love with melancholy winds and purling rills, and waterfalls and nodding groves; but their poetry was the poetry of hard work and hard fare, unselfish hearts and charitable hands. They could plough and reap, they could hedge and ditch, they could drain; they could lop, they could carpenter; they could thatch, they could make hurdles for their huts; they could make a road, they could divert or secure the streamlet's bed, they could bridge a torrent. Mr. Warner mentions one of their luxuries,—clear, wholesome water; it was an allowable one, especially as they obtained it by their own patient labour. If their grounds are picturesque, if their views are rich, they made them so, and had, we presume,

[12] Vol. i., p. 237, etc.

a right to enjoy the work of their own hands. They found a swamp, a moor, a thicket, a rock, and they made an Eden in the wilderness. They destroyed snakes; they extirpated wild cats, wolves, boars, bears; they put to flight or they converted rovers, outlaws, robbers. The gloom of the forest departed, and the sun, for the first time since the Deluge, shone upon the moist ground. St. Benedict is the true man of Ross.

They made a garden in the wilderness,

> Who hung with woods yon mountain's sultry brow?
> From the dry rock who made the waters flow?
> Whose causeway parts the vale with shady rows?
> Whose seats the weary traveller repose?
> He feeds yon almshouse, neat, but void of state,
> When Age and Want sit smiling at the gate;
> Him portioned maids, apprenticed orphans blessed,
> The young who labour, and the old who rest.

as candid Protestants confess.

And candid writers, though not Catholics, allow it. Even English, and much more foreign historians and antiquarians, have arrived at a unanimous verdict here. "We owe the agricultural restoration of great part of Europe to the monks", says Mr. Hallam. "The monks were much the best husbandmen, and the only gardeners", says Forsyth. "None", says Wharton, "ever improved their lands and possessions more than the monks, by building, cultivating, and other methods". The cultivation of Church lands, as Sharon Turner infers from Doomsday Book, was superior to that held by other proprietors, for there was less wood upon them, less common pasture, and more abundant meadow. "Wherever they came", says Mr. Soame on Mosheim, "they converted the wilderness into a cultivated country; they pursued the breeding of cattle and agriculture, laboured with their own hands, drained morasses, and cleared away forests. By them Germany was rendered a fruitful country". M. Guizot speaks as strongly: "The Benedictine monks were the agriculturists of Europe; they cleared it on a large scale, associating agriculture with preaching".[13]

Instances in point

St. Benedict's direct object in setting his monks to manual labour, was neither social usefulness nor poetry, but penance; still his work was both the one and the

[13] Hallam, Middle Ag., vol. iii., p. 436. Forsyth, Antiqu., vol. i., pp. 37, 44, 179. Turner, Anglo-Sax., vol. ii., p. 167. Murdoch's Mosheim, vol. ii., p. 21, etc. Guizot, Hist. Civil., vol. ii., p. 75, Bohn.

other. The above cited authors enlarge upon its use, and we may be allowed to dwell upon its poetry; we may contemplate both its utility to man and its service to God in the aspect of its poetry. How romantic then, as well as useful, how lively as well as serious, is their history, with its episodes of personal adventure and prowess, its pictures of squatter, hunter, farmer, civil engineer, and evangelist united in the same individual, its supernatural colouring of heroic virtue and miracle! When St. Columban first came into Burgundy with his twelve young monks, he placed himself in a vast wilderness, and made them set about cultivating the soil. At first they all suffered from hunger, and were compelled to live on the barks of trees and wild herbs. On one occasion they were for five days in this condition. St. Gall, one of them, betook himself to a Swiss forest, fearful from the multitude of wild beasts; and then, choosing the neighbourhood of a mountain stream, he made a cross of twigs, and hung some relics on it, and laid the foundation of his celebrated abbey. St. Ronan came from Ireland to Cornwall, and chose a wood, full of wild beasts, for his hermitage, near the Lizard. The monks of St. Dubritius, the founder of the Welsh Schools, also sought the woods, and there they worked hard at manufactures, agriculture, and road making. St. Sequanus placed himself where "the trees almost touched the clouds". He and his companions, when they first explored it, asked themselves how they could penetrate into it, when they saw a winding footpath, so narrow and full of briars, that it was with difficulty that one foot followed another. With much labour and with torn clothes they succeeded in gaining its depths, and stooping their heads into the darkness at their feet, they perceived a cavern, shrouded by the thick interlacing branches of the trees, and blocked up with stones and underwood. "This", says the monastic account, "was the cavern of robbers, and the resort of evil spirits". Sequanus fell on his knees, prayed, made the sign of the Cross over the abyss, and built his cell there. Such was the first foundation of the celebrated abbey called after him in Burgundy.[14]

in France,

Switzerland,

England,

Wales,

Sturm, the Bavarian convert of St. Boniface, was

Germany.

[14] Neander, Memorials, pp. 436, 451, 473, Bohn. Rader, Bavaria Sacra. Calles Ann. Germ., t. i. pp. 200, 276, 317, 318. Guizot, Civil., vol. ii., p. 134. Whitaker's Cornwall, vol. ii., p. 196. Fosbroke, Antiq., p. 16.

seized with a desire, as his master had been in his English monastery, of founding a religious house in the wilds of pagan Germany; and setting out with two companions, he wandered for two days through the Buchonian forest, and saw nothing but earth, sky, and large trees. On the third day he stopped and chose a spot, which on trial did not answer. Then, mounting an ass, he set out by himself, cutting down branches of a night to secure himself from the wild beasts, till at length he came to the place (described by St. Boniface as "locum silvaticum in eremo, vastissimæ solitudinis"), in which afterwards arose the abbey and schools of Fulda. Wunibald was suspicious of the good wine of the Rhine where he was, and, determining to leave it, he bought the land where Heidensheim afterwards stood, then a wilderness of trees and underwood, covering a deep valley and the sides of lofty mountains. There he proceeded, axe in hand, to clear the ground for his religious house, while the savage natives looked on sullenly, jealous for their hunting grounds and sacred trees. Willibald, his brother, had pursued a similar work on system; he had penetrated his forest in every direction and scattered monasteries over it. The Irish Alto pitched himself in a wood, half way between Munich and Vienna. Pirminius chose an island, notorious for its snakes, and there he planted his hermitage and chapel, which at length became the rich and noble abbey and school of Augia Major or Richenau.[15]

Instance of Bec. The more celebrated School of Bec had a similar beginning at a later date, when Herluin, an old soldier, devoted his house and farm to an ecclesiastical purpose, and governed, as abbot, the monastery which he had founded. "You might see him", says the writer of his life, "when office was over in church, going out to his fields, at the head of his monks, with his bag of seed about his neck, and his rake or hoe in his hand. There he remained with them hard at work till the day was closing. Some were employed in clearing the land of brambles and weeds; others spread manure; others were weeding or sowing; no one ate his bread in idleness. Then when the hour came for saying office in church, they all assembled together punctually. Their ordinary food was

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[15] Meyrick's Willibald, p. 68. Bavaria Sacra, p. 119. Petri, Suevia Eccles., p. 96. Calles Ann. Germ. t. i., p. 191.

bread of bran,[16] and vegetables with salt and water; and the water muddy, for the well was two miles off".[17] Lanfranc, then a secular, was so overcome by the simple Abbot, fresh from the field, setting about his baking with dirty hands, that he forthwith became one of the party;[18] and, being unfitted for labour, opened in the house a school of logic, thereby to make money for the community. Such was the cradle of the scholastic theology; the last years of the patristic, which were nearly contemporaneous, exhibit a similar scene:—St. Bernard founding his abbey of Clairvaux in a place called the Valley of Wormwood, in the heart of a savage forest, the haunt of robbers, and his thirteen companions grubbing up a homestead, raising a few huts, and living on barley or cockle bread with boiled beech leaves for vegetables.[19] **of Clairvaux,**

How beautiful is Simeon of Durham's account of Easterwine, the first abbot after Bennet of St. Peter's at Wearmouth! He was a man of noble birth, who gave himself to religion, and died young. "Though he had been in the service of King Egfrid", says Simeon, "when he had once left secular affairs, and laid aside his arms, and taken on him the spiritual warfare instead, he was nothing but the humble monk, just like any of his brethren, winnowing with them with great joy, milking the ewes and cows, and in the bakehouse, the garden, the kitchen, and all house duties, cheerful and obedient. And, when he received the name of Abbot, still he was in spirit just what he was before to every one, gentle, affable, and kind; or, if any fault had been committed, correcting it indeed by the Rule, but still so winning the offender by his unaffected earnest manner, that he had no wish ever to repeat the offence, or to dim the brightness of that most clear countenance with the cloud of his transgression. And often going here and there on business of the monastery, when he found his brothers at work, he would at once take part in it, guiding the plough, or shaping the iron, or taking the winnowing fan, or the like. He was young and strong, with a sweet voice, a cheerful temper, a liberal heart, and a handsome countenance. He partook of the same food as his brethren, and under **of Easterwine at Wearmouth.**

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[16] Siligineus, i. e. *wheaten;* but can it be quasi ex siliquâ, not, ex siligine? *vid.* Hor. Ep. lib. 2, 123.

[17] Butler's Lives, Aug. 20.

[18] Apud. Mabillon Act. Bened.

[19] Thomass. Disc. Eccl. t. iii. p. 513.

the same roof. He slept in the common dormitory, as before he was abbot, and he continued to do so for the first two days of his illness, when death had now seized him, as he knew full well. But for the last five days he betook himself to a more retired dwelling; and then, coming out into the open air and sitting down, and calling for all his brethren, after the manner of his tender nature, he gave his weeping monks the kiss of peace, and died at night while they were singing lauds".[20]

Amiableness of the monastic character.

This gentleness and tenderness of heart seems to have been as characteristic of the monks as their simplicity; and if there are some Saints among them, who on the public stage of history do not show it, it was because they were called out of their convents for some special purpose. Bede goes out of his way to observe of Ethelbert, on St. Austin's converting him, that "he had learned from the teachers and authors of his salvation, that men were to be drawn heavenwards, and not forced". Aldhelm, when a council had been held about the perverse opinions of the British Christians, seconding the principle which the Fathers of it laid down, that "schismatics were to be convinced, not compelled", wrote a book upon their error and converted many of them. Wolstan, when the civil power failed in its attempts to stop the slave trade of the Bristol people, succeeded by his persevering preaching. In the confessional he was so gentle, that penitents came to him from all parts of England.[21] This has been the spirit of the monks from the first; the student of ecclesiastical history may recollect a certain passage in St. Martin's history, when his desire to shield the Spanish heretics from death brought him into difficulties, from which he hardly escaped, in his mode of dealing with the usurper Maximus.

Penance subservient to almsgiving.

Penance indeed and mercy have gone hand in hand in the history of the monks; from the Solitaries in Egypt down to the Trappists of this day, it is one of the points in which the unity of the monastic idea shows itself. They have ever toiled for others, while they toiled for themselves; nor for posterity only, but for their poor neighbours, and for travellers who came to them. St. Augustine tells us, that the monks of Egypt and of the East made so much by manual labour as to be able to freight vessels with provisions for impoverished districts.

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[20] P. 93. The passage seems taken from Bede.
[21] Bede, Hist. Eccles., i. 26. William of Malmesb. Ponfic. Angl.

Theodoret speaks of a certain five thousand of them, who by their labour supported, besides themselves, innumerable poor and strangers. Sozomen speaks of the monk Zeno, who, though a hundred years old, and the bishop of a rich Church, worked for the poor as well as for himself. Corbinian in a subsequent century surrounded his German Church with fruit trees and vines, and sustained the poor with the produce. The monks of St. Gall, already mentioned, gardened, planted, fished, and thus secured the means of relieving the poor and entertaining strangers. "Monasteries", says Neander, "were seats for the promotion of various trades, arts, and sciences. The gains accruing from their combined labour were employed for the relief of the distressed. In great famines, thousands were rescued from starvation".[22] In a scarcity at the beginning of the twelfth century, a monastery in the neighbourhood of Cologne distributed in one day fifteen hundred alms, consisting of bread, meat, and vegetables. About the same time, St. Bernard founded his monastery of Citeaux, which, though situated in the waste district described above, was able at length to sustain two thousand poor for months, besides extraordinary alms bestowed on others. The monks offered their simple hospitality, uninviting as it might be, to high as well as low; and to those who scorned their fare, they at least could offer a refuge in misfortune or danger, or after casualties.

Instances in point.

Duke William, ancestor of the Conqueror, was hunting in the woods about Jumieges, when he fell in with a rude hermitage.[23] Two monks had made their way through the forest, and with immense labour had rooted up some trees, levelled the ground, raised some crops, and put together their hut. William heard their story, not perhaps in the best humour, and flung aside in contempt the barley bread and water which they offered him. Presently he was brought back wounded and insensible: he had got the worst in an encounter with a boar. On coming to himself, he accepted the hospitality which he had refused at first, and built for them a monastery. Doubtless he had looked on them as trespassers or squatters on his domain, though with a religious character and object. The Norman princes were as good friends to the wild beasts as the monks were enemies: a charter still exists of the Con-

Abbey of Jumieges.

[22] Eccl. Hist., vol. vii., p. 331, Bohn.
[23] Duchesne, Script. North., p. 236.

queror granted to the abbey of Caen,[24] in which he stipulates that its inmates should not turn the woods into tillage, and reserves the game for himself.

Monastery of Subiaco.

Contrast with this savage retreat and its rude hospitality, the different, though equally Benedictine picture of the sacred grove of Subiaco, and the spiritual entertainment which it ministers to all comers, as given in the late pilgrimage of Bishop Ullathorne: "The trees", he says, "which form the venerable grove, are very old, but their old age is vigorous and healthy. Their great gray roots expose themselves to view with all manner of curling lines and wrinkles on them, and the rough stems bend and twine about with the vigour and ease of gigantic pythons. . . . Of how many holy solitaries have these trees witnessed the meditations! And then they have seen beneath their quiet boughs the irruption of mailed men, tormented by the thirst of plunder and the passion of blood, which even a sanctuary held so sacred could not stay. And then they have witnessed, for twelve centuries and more, the greatest of the Popes, the Gregories, the Leos, the Innocents, and the Piuses, coming one after another to refresh themselves from their labours in a solitude which is steeped with the inspirations and redolent with the holiness of St. Benedict.[25]

Benedictine life a fit subject for Virgil.

What congenial subjects for his verse would the sweetest of all poets have found in scenes and histories such as the foregoing, he who in his Georgics has shown such love of a country life and country occupations, and of the themes and trains of thought which rise out of the country! Would that Christianity had a Virgil to describe the old monks at their rural labours, as it has had a Sacchi or a Domenichino to paint them! How would he have been able to set forth the adventures and the hardships of the missionary husbandmen, who sang of the Scythian winter, and the murrain of the cattle, the stag of Sylvia, and the forest home of Evander! How could he have pourtrayed St. Paulinus or St. Serenus in his garden, who could draw so beautiful a picture of the old Corycian, raising amid the thicket his scanty potherbs upon the nook of land, which was "not good for tillage, nor for pasture, nor for vines"! How could he have brought out the poetry of those simple labourers, who has told us of that old man's flowers and fruits, and of the satisfaction, as a

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[24] Turner, Middle Ag., vol. v., p. 89. [25] P. 37.

king's, which he felt in those innocent riches! He who had so huge a dislike of cities, and great houses, and high society, and sumptuous banquets, and the canvass for office, and the hard law, and the noisy lawyer, and the statesman's harangue,—he who thought the country proprietor as even too blessed, did he but know his blessedness, and who loved the valley, winding stream, and wood, and the hidden life which they offer, and the deep lessons which they whisper,—how could he have illustrated that wonderful union of prayer, penance, toil, and literary work, the true "otium cum dignitate", a fruitful leisure and a meek-hearted dignity, which is exemplified in the Benedictine! That ethereal fire which enabled the prince of Latin poets to take up the Sibyl's strain, and to adumbrate the glories of a supernatural future, that serene philosophy, which has strewn his poems with sentiments which come home to the heart, that intimate sympathy with the sorrows of human kind and with the action and passion of human nature, how well would they have served to illustrate the patriarchal history and office of the monks in the broad German countries, or the deeds, the words, and the visions of a St. Odilo or a St. Aelred!

from his love of rural labours, of communion with nature, of philosophic meditation;

What a poet deliberately chooses for the subject of his poems, must be in its own nature poetical. A poet indeed is but a man after all, and in his proper person may prefer solid beef and pudding to all the creations of his own "fine frenzy", which, in his character of poet, are his meat and drink. But no poet will ever commit his poetical reputation to the treatment of subjects which do not admit of poetry. When, then, Virgil chooses the country and rejects the town, he shows us that a certain aspect of the town is uncongenial with poetry, and that a certain aspect of the country is congenial. Repose, intellectual and moral, is that quality of country life which he selects for his praises; and effort, and bustle, and excitement is that quality of a town life which he abhors. Herein then, according to Virgil, lies the poetry of St. Benedict, in the "secura quies et nescia fallere vita", in the absence of anxiety and fretfulness, of schemes and scheming, of hopes and fears, of doubts and disappointments. Such a life,—living for the day without solicitude for the morrow, without plans or objects, even holy ones, here below; working, not (so to say) by the piece, but as hired by the hour; sowing the ground with the certainty, according to the promise, of reaping; reading

and therefore poetical.

or writing this present week without the consequent necessity of reading or writing during the next; dwelling among one's own people without distant ties; taking each new day as a whole in itself, an addition, not a complement, to the past; and doing works which cannot be cut short, for they are complete in every portion of them,—such a life may be called emphatically Virgilian. They, on the contrary, whose duty lies in what may be called *undertakings*, in science and system, in sustained efforts of the intellect or elaborate processes of action,—apologists, controversialists, disputants in the schools, professors in the chair, teachers in the pulpit, rulers in the Church,—have a noble and meritorious mission, but not so poetical a one. When the bodily frame receives an injury, or is seized with some sudden malady, nature may be expected to set right the evil, if left to itself, but she requires time; science comes in to shorten the process, and is violent that it may be certain. This may be taken to illustrate St. Benedict's mode of counteracting the miseries of life. He found the world, physical and social, in ruins, and his mission was to restore it in the way, not of science, but of nature, not as if setting about to do it, not professing to do it by any set time or by any rare specific or by any series of strokes, but so quietly, patiently, gradually, that often, till the work was done, it was not known to be doing. It was a restoration, rather than a visitation, correction, or conversion. The new world which he helped to create was a growth rather than a structure. Silent men were observed about the country, or discovered in the forest, digging, clearing, and building; and other silent men, not seen, were sitting in the cold cloister, tiring their eyes, and keeping their attention on the stretch, while they painfully deciphered and copied and re-copied the manuscripts which they had saved. There was no one that "contended, or cried out", or drew attention to what was going on; but by degrees the woody swamp became a hermitage, a religious house, a farm, an abbey, a village, a seminary, a school of learning, and a city. Roads and bridges connected it with other abbeys and cities, which had similarly grown up; and what the haughty Alaric or fierce Attila had broken to pieces, these patient meditative men had brought together and made to live again.

results of Benedictines

resemble nature, not art,

a growth not a work.

And then, when they had in the course of many years gained their peaceful victories, perhaps some new invader

came, and with fire and sword undid their slow and persevering toil in an hour. The Hun succeeded to the Goth, the Lombard to the Hun, the Tartar to the Lombard; the Saxon was reclaimed only that the Dane might take his place. Down in the dust lay the labour and civilization of centuries,—Churches, Colleges, Cloisters, Libraries,—and nothing was left to them but to begin all over again; but this they did without grudging, so promptly, cheerfully, and tranquilly, as if it were by some law of nature that the restoration came, and they were like the flowers and shrubs and fruit trees which they reared, and which, when ill-treated, do not take vengeance, or remember evil, but give forth fresh branches, leaves, or blossoms, perhaps in greater profusion, or with richer quality, for the very reason that the old were rudely broken off. If one holy place was desecrated, the monks pitched upon another, and by this time there were rich or powerful men who remembered and loved the past enough, to wish to have it restored in the future. Thus was it in the case of the monastery of Ramsey after the ravages of the Danes. A wealthy Earl, whose heart was touched, consulted his Bishop how he could best promote the divine glory: the Bishop answered that they only were free, serene, and unsolicitous, who renounced the world, and that their renunciation brought a blessing on their country. "By their merit", he said, "the anger of the Supreme Judge is abated; a healthier atmosphere is granted; corn springs up more abundantly; famine and pestilence withdraw; the state is better governed; prisons are opened; the fetters unbound; the shipwrecked relieved". He proceeded to advise him, as the best of courses, to give ground for a monastery, and to build and endow it. Earl Alwin observed in reply, that he had inherited some waste land in the midst of marshes, with a forest in the neighbourhood, some open spots of good turf, and others of meadow; and he took the Bishop to see it. It was in fact an island in the fens, and as lonely as religious men could desire. The gift was accepted, workmen were collected, the pious peasants round about gave their labour. Twelve monks were found from another cloister; cells and a chapel were soon raised. Materials were collected for a handsome church; stones and cement were given; a firm foundation was secured; scaffolding and machinery were lent; and in course of time a sacred edifice and two towers rose over the desolate waste, and renewed the past;—a

Their patience in restoring what was destroyed,

like that of nature.

Instance of Abbey of Ramsey.

learned divine from France was invited to preside over the monastic schools.[26]

Their literary labours

Here then we are led lastly to speak of the literary labours of the Benedictines, but we have not room to do more than direct attention to the peculiar character of their work, and must pass over their schools altogether. Here, as in other respects above noticed, the unity of monachism shows itself. What the Benedictines have been, even in their latest literary developments, in St. Maur in the seventeenth century, and at Solesme now, such were the monks in their first years. One of the chief occupations of the disciples of St. Pachomius in Egypt, was the transcription of books. It was the sole labour of the monks of St. Martin in Gaul. The Syrian solitaries, according to St. Chrysostom, employed themselves in making copies of the Holy Scriptures. It was the occupation of the monks of St. Equitius and of Cassiodorus, and of the nunnery of St. Cæsarius. We read of one holy man preparing the skins for writing, of another selling his manuscripts in order to gain alms for the poor, and of an abbess writing St. Peter's Epistles in letters of gold. St. David had shown the same reverence to St. John's Gospel. Abbot Plato filled his own and other monasteries with his beautifully written volumes.[27] During the short rule of Abbot Desiderius at Monte Cassino, his monks wrote out St. Austin's fifty Homilies, his Letters, his Comment upon the Sermon on the Mount, upon St. Paul and upon Genesis; parts of St. Jerome and St. Ambrose, part of St. Bede, St. Leo's Sermons, the Orations of St. Gregory Nazianzen; the Acts of the Apostles, the Epistles and the Apocalypse; various histories, including that of St. Gregory of Tours, Josephus on the Jewish War, Justinian's Institutes, and many ascetic and other works; of the Classics, Cicero de Naturâ Deorum, Terence, Ovid's Fasti, Horace, and Virgil. Maurus Lapi, a Camaldolese, in the fifteenth century, copied a thousand volumes in less than fifty years. Jerome, a monk in an Austrian monastery, wrote so great a number of books, that, it is said, a wagon with six horses would scarcely suffice to draw them. Othlon, in the eleventh century, when a boy, wrote so diligently,

combined with alms-giving.

Transcription of MSS. in point.

[26] *Vide* Turner, Anglo-Saxons, vol. iii., p. 468.

[27] Pallad, c. 39. Cassian, Inst., iv., 12. Calmet, Reg., t. ii., p. 150. Thomassin, Disc. Eccl., t. iii., p. 505. Ziegelbaum, Hist. Litt. Bened., t. ii., p. 510.

that he nearly lost his sight. That was in France; he then went to Ratisbon, where he wrote nineteen missals, three books of the Gospel, two books of Epistle and Gospel, and many others. Many he gave to his friends, but the list is too long to finish. The Abbot Odo of Tournay "used to exult", according to his successor, "in the number of writers which the Lord had given him. Had you gone into his cloister, you might have seen a dozen young men sitting in perfect silence, writing at tables, constructed for the purpose. All Jerome's Commentaries on the Prophets, all the works of St. Gregory, all that he could find of Austin, Ambrose, Isidore, Bede, and the Lord Anselm, Abbot of Bec, and afterwards Archbishop of Canterbury, he caused to be diligently transcribed".[38]

Calligraphy, illumination, decoration.

These tranquil labourers found a further field in the illumination and binding of the transcribed volumes, as they had previously been occupied in the practice necessary for the then important art of calligraphy. It was not running hand that the monks had to learn; for it was no ephemeral expression of their own thoughts, which their writing was to convey, but the formal transcript, for the benefit of posterity, of the words of inspired teachers and Doctors of the Church. They were performing what has been since the printer's work; and it is said that from the English monks is derived the small letter of the modern Roman type. In France the abbeys of Fontenelle, Rheims, and Corbie were especially famed for beauty of penmanship in the age of Charlemagne,[39] when literature was in its most depressed state. Books intended for presents, such as that which the mother of Leo the Ninth presented to St. Hubert, and, much more, if intended for sacred uses, were enriched with gold and silver plates and precious stones. Here was a commencement of the cultivation of the fine arts in those turbulent times,—a quiet, unexciting occupation, which went on inside the monasteries, whatever rivalries or heresies agitated Christendom outside of them, and which, though involving, of course, an improvement in the workmanship as time went on, yet in the case of every successive spe-

Instances.

The fine arts.

[38] Annal. Camald., t. vii., p. 300: *vid.* other instances in Maitland's Dark Ages, and Buckingham's Bible in the Middle Ages, who is deficient in references.

[39] Guizot's Hist. Civil, vol. ii., p. 236, Bohn.

cimèn, whatever exact degree of skill or taste each exhibited, had its end in itself, as though there had been no other specimen before or after.

Instance of Fulda. Brower, in his work on the Antiquities of Fulda, gives us a lively picture of the various tranquil occupations, which were going on at one time within the monastic walls. "As industrious bees", he says, "their work never flagging, did these monks follow out their calling. Some of them were engaged in describing, here and there upon the parchment, the special letters and characters which were to be filled in; others were wrapping or binding the manuscripts in handsome covers; others were marking out in red the remarkable sentences or the heads of the chapters. Some were writing fairly what had been thrown together at random, or had been left out in the dictation, and were putting every part in fair order. And not a few of them excelled in painting in all manner of colours, and in drawing figures".[30] He goes on to refer to an old manuscript there which speaks of the monks as decorating their church, and of their carpenters' work, sculpture, engraving, and brass work.

Goldsmiths' work.

St. Dunstan. We have mentioned St. Dunstan in an earlier page, as called to political duties, which were out of keeping with the traditionary spirit of his Order; here, however, he shows himself in the simple character of a Benedictine. He had a taste for the arts generally, especially music. He painted and embroidered; his skill in smith's work is recorded in the well-known legend of his combat with the evil one. And, as the monks of Hilarion joined gardening with psalmody, and Bernard and his Cistercians joined field work with meditation, so did St. Dunstan use music and painting as directly expressive or suggestive of devotion. "He excelled in writing, painting, moulding in wax, carving in wood and bone, and in work in gold, silver, iron, and brass", says the writer of his life in Surius. "And he used his skill in musical instruments, to charm away himself and others from secular annoyances, and to rouse them to the thought of heavenly harmony, both by the sweet words with which he accompanied his airs, and by the concord of those airs themselves".[31] And then he goes on to mention, how on one occasion, when

Music.

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[30] P. 45.

[31] *Vid.* also Whitaker's Cornwall, vol. i., p. 167, and the whole chapter.

he had hung his harp against the wall, and the wind brought out from its strings a wild melody, he recognized in it one of the antiphons in the Commune Martyrum, "Gaudete in Cœlis", etc., and used it for his own humiliation.

Mosaic, inlaying, etc.

As might be expected, the monasteries of the South of Europe would not be behind the North in accomplishments of this kind. Those of St. Gall, Monte Cassino, and Solignac, are especially spoken of as skilled in the fine arts. Monte Cassino excelled in *miniatura* and mosaic, the Camaldolese in painting, and the Olivetans in wood-inlaying.[22]

Their study of Scripture and the Fathers.

While manual labour, applied to these artistic purposes, ministered to devotion, on the other hand, when applied to the transcription and multiplication of books, it was a method of instruction, and that peculiarly Benedictine, as being of a literary, not a scientific nature. Systematic theology had but a limited place in ecclesiastical study prior to the eleventh and twelfth centuries; Scripture and the Fathers were the received means of education, and these constituted the very text on which the pens of the monks were employed. And thus they would be becoming familiar with that kind of knowledge which was proper to their vocation, at the same time that they were engaged in what was unequivocally a manual labour; and, in providing for the religious necessities of posterity, they were directly serving their own edification. And this again had been the practice of the monks from the first, and is included in the *unity* of their profession. St. Chrysostom tells us that their ordinary occupation in his time was "to sing and pray, to read Scripture, and to transcribe the sacred text".[23] As the writings of the Fathers gradually became the literary property of the Church, these, too, became the subject matter of the reading and the writing of the monks. "For him who is going on to perfection", says St. Benedict in his Rule, "there are the lessons of the Holy Fathers, which lead to its very summit. For what page, what passage of the Old or New Testament, coming as it does with divine authority, is not the very exactest rule of life? What book of the Holy Catholic Fathers does not resound with this one theme, how we may take the shortest course to

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[22] Meehan's Marchese, p. xxiv.
[23] Hist. Liter. de St. Maur, 1770, p. 21.

our Creator?" But we need not here insist on this characteristic of monastic study, which, especially as regards the study of Scripture, has been treated so fully and so well by Mr. Maitland in his "Essays on the Dark Ages".

Their Catenæ and Summæ.

The sacred literature of the monks went a step further. They would be naturally led by their continual perusal of the Scriptures and the Fathers, to attempt to compare and adjust these two chief sources of theological truth with each other. Hence resulted the peculiar character of the religious works of what may be especially called the Benedictine period, the five centuries between St. Gregory and St. Anselm. The age of the fathers was well nigh over; the age of the schoolmen was yet to come; the ecclesiastical writers of the intervening period employed themselves for the most part in arranging and digesting the patristical literature which had come down to them; they either strung together choice passages of the Fathers in *catenæ*, as a running illustration of the inspired text, or they formed them into a comment upon it. The *Summæ Sententiarum* of the same period were works of a similar character, while they also opened the way to the intellectual exercises of the scholastic period; for they were lessons or instructions arranged according to a scheme or system of doctrine, though they were still extracted from the works of the Fathers, and though the matter of those works suggested the divisions or details of the system. Moreover, such labours, as much as transcription itself, were Benedictine in their spirit, as well as in their subject matter; for where there was nothing of original research, nothing of brilliant or imposing result, there would be nothing to dissipate, elate, or absorb the mind, or to violate the simplicity and tranquillity proper to the monastic state.

Their annals and chronicles,

The same remark applies to a further literary employment in which the Benedictines allowed themselves, and which is the last we shall here mention, and that is the compilation of chronicles and annals, whether ecclesiastical, secular, or monastic. So prominent a place does this take in their literature, that the author of the *Asceticon*, in the fourth volume of Dom Francois's Bibliotheque des Ecrivains Bénédictins, does not hesitate to point to the historical writings of his Order as constituting one of its chief claims, after its Biblical works, on the gratitude of posterity. "This", he says, "is the praise especially due to the monks, that they have illustrated Holy Scripture, rescued history, sacred and profane, from the barbarism

of the times, and have handed down to posterity so many lives both of Saints and of Bishops".[34] Here again is a fresh illustration of the Benedictine character; for first, those histories are of the most simple structure and most artless composition, and next, from the circumstance of their being commonly narratives of contemporary events, or compilations from a few definite sources of information which were at hand, they involved nothing of that laborious research and excitement of mind which is demanded of the writer who has to record a complex course of history, extending over many centuries and countries, and who aims at the discovery of truth, in the midst of deficient, redundant, or conflicting testimony. "The men who wrote history", says Mr. Dowling, speaking of the times in question, "did not write by rule; they only put down what they had seen, what they had heard, what they knew. Very many of them did what they did as a matter of moral duty. The result was something *sui generis;* it was not even what *we* call history at all. It was, if I may so speak, something more, an actual admeasurement rather than a picture; or, if a picture, it was painted in a style, which had all the minute accuracy and homely reality of the most domestic of the Flemish masters, not the lofty hyperbole of the Roman school, nor the obtrusive splendour, not less unnatural, of the Venetian. In a word, history, as a subject of criticism, is an art, a noble and beautiful *art;* the historical writings of the middle ages is *nature*".[35]

not philosophic histories,

Allusion is made in this passage to the peculiarity in monastic historiography, that it proceeded from the motive of religious obedience. This must always have been the case from the monastic profession; however, we have here, in addition to the presumption, actual evidence, and not on one occasion only, of the importance which the Benedictine Order attached to these notices and memorials of past times. In the year 1082, for instance, the Abbot Marquand of New Corbie in Saxony seems to have sent an order to all churches and monasteries subject to his rule, to send to him severally the chronicles of their own places. Abbot Wichbold repeated the order sixty years later, and Abbot Thierry in 1337 addressed to the provosts and rectors subject to him, a like injunction.[36] Again,

much insisted on.

[34] P. 379. Printing, another tranquil work, was introduced into Italy by the Benedictines of Subiaco. *Vid.* Dr. Ullathorne's Pilgrimage.
[35] Introd. Eccles. Hist., p. 56. [36] Ziegelbaur, t. ii., p. 401.

in 1481 the Abbot of Erfurdt addressed a letter to the Fathers of the Reform of Bursfeld, with the view of persuading them to enter into a similar undertaking. "If you were to agree, among yourselves", he says, "and make a statute to the effect that every Prelate is under an obligation to compose annals and histories of his monastery, what could be better, what more useful, what more interesting, whether for knowing or for reading?"[37]

What place literature had in their employments.

It is easier to conjecture what those literary works would be, in which a Benedictine would find himself at liberty to engage, than to pretend to point out those from which his vocation would debar him; yet Mabillon, equally with de Rancé, implied that all subjects do not come alike to him. Here we are recalled to the well known controversy between these two celebrated men. The Abbot of La Trappe, the Cistercian de Rancé, writing to his own people, put forth some statements on the subject of the studies proper to a monk, which seemed to reflect upon the learned Maurists. Mabillon, one of them, replied, in a learned vindication of himself and his brethren. The Abbot had maintained that study of whatever kind should be kept in strict subordination to manual labour, and should not extend to any books except the Scriptures and the ascetic treatises of the Fathers. Mabillon, on the other hand, without denying the necessity of manual labour, to which the Maurists themselves devoted an hour a day, seemed to allow to the Benedictine the free cultivation of the intellect, and an unlimited range of studies. When they explained themselves, each combatant would appear to have asserted more than he could successfully maintain; yet after all there was a considerable difference of view between them, which could not be removed. The critical question was, whether certain historical instances, which Mabillon urged in his favour, were to be considered exceptions or not to the rule of St. Benedict. For ourselves, we have certainly maintained in an earlier page of this article, that such instances as Alcuin, Paschasius, or Lanfranc are no fair specimens of the Benedictine profession, and must not be taken to represent the monks generally. Lest, however, in saying this, we may be thought to be evading the testimony of history, as adduced by a writer, authoritative at once by his learning and as spokes-

Controversy on the subject between de Rancé and Mabillon.

[37] *Ibid.*, t. i., p. 424. For lists of monastic histories, *vide* Mr. Dowling, as above, p. 260; the Asceticon as above, § 26. Ziegelbaur, t. ii., p. 398. Balmez, Prot. and Cath., p. 195.

man of the great Congregation of St. Maur, we think it well to extract in our behalf some of his own admissions, which seem to us fully to bear out what we were laying down above about the spirit and mission of his Order.

Concessions of Mabillon.

For instance, he frankly concedes, or rather maintains, that the scholastic method of teaching theology and philosophy is foreign to the profession of a Benedictine, as such. "Why", he asks, "need we cultivate these sciences in the way of disputation? Why not as positive sciences, explaining questions and resolving doubts, as they occur? Why is it not more than enough for religious pupils to be instructed in the more necessary principles of the science, and thereby to make progress in the study of the Scriptures and the Fathers? What need of this perpetual syllogizing in form, and sharp answers to innumerable objections, as is the custom in the schools?" Elsewhere, he contrasts the mode of teaching a subject, as adopted by the early Fathers, with that which the schoolmen introduced. "The reasonings of the Fathers", he says, "are so full, so elegantly set forth, as to be everywhere redolent of the sweetness and vigour of Christian eloquence, whereas scholastic theology is absolutely dry and sterile". Elsewhere he says, that "in the study of Holy Scripture consists the entire science of monks". Again, he says of Moral Theology, "As monks are rarely destined to the cure of souls, it does not seem necessary that they should give much time to the science of Morals". And, though of course he does not forbid them the study of history, which we have seen to be so congenial to their calling, yet he observes of this study when pursued to its full extent, "It seems to cause much dissipation of mind, which is prejudicial to that inward compunction of heart, which is so especially fitting to the holy life of a monk". Again, observing that the examination of ancient MSS. was the special occupation of the Maurists in his time, he says, "They who give themselves to this study have the more merit with God, in that they have so little praise with men. Moreover, it obliges them to devote the more time to solitude, which ought to be their chief delight. I confess it is a most irksome and unpleasant labour; however, it gives much less trouble than transcription, which was the most useful work of our early monks". Elsewhere, speaking of the celebrated Maurist editions of the Fathers, he observes, "Labour, such as this, which is undergone in silence and in quietness, is especially

He gives up disputation, moral theology, general history.

Insists on investigation of MSS., and editions of the Fathers.

compatible with true tranquillity of mind, and the mastery of the passions, provided we labour as a duty, and not for glory".[38]

On the whole, what literature not Benedictine,

We trust the reader will be so good as to keep in mind that we are all along speaking of the Benedictine life *historically*, and as we might speak of any other historical *fact;* not venturing at all on what would be the extreme presumption of any quasi-doctrinal or magisterial exposition of it, which belongs to those only who have actually imbibed its tradition. This being clearly understood, we think we may interpret Mabillon to mean that (be the range of studies lawful to a monk what it may) still, whatever literary work requires such continuous portions of time as not to admit of being suspended at a moment's notice, whatever is so interesting that other duties seem dull and heavy after it, whatever so exhausts the power of attention as to incapacitate for attention for other subjects, whatever makes the mind gravitate towards the creature, is inconsistent with monastic simplicity. Accordingly, we should expect to find that controversy was uncongenial to the Benedictine, because it excited the mind, and metaphysical investigations, because they fatigued it; and, when we met such instances as St. Paschasius or St. Anselm, we should deal with them as they came and as we could. Moreover, we should not look to a Benedictine for any elaborate and systematic work on the history of doctrine, or of heresy, or any course of patristical theology, or any extended ecclesiastical history, or any philosophical disquisitions upon history, as implying a grasp of innumerable details, and the labour of using a mass of phenomena to the elucidation of a theory, or of bringing a range of multifarious reading to bear upon one point; and that, because such efforts of mind require either an energetic memory devoted to matters of time and place, or, instead of the tranquil and plodding study of one book after another, the presence of a large library, and the distraction of a vast number of books handled all at once, not for perusal, but for reference. Perhaps we are open to the charge of refining, in attempting to illustrate the principle which we seem to ourselves to detect in the Benedictine tradition; but the principle itself which we have before us is clear enough, and is expressed in the advice which is given to

not polemical, nor metaphysical, nor systematic.

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[38] Stud. Monast., ed. 1732; t. i, pp. 52, 135; t. ii p. 2; t. i., pp. 145, 147, 191, 64.

us by a sacred writer: "The words of the wise are as goads, and nails deeply fastened in; *more than these, my son, require not:* of making many books there is no end, and much study is an affliction of the flesh".

Contrasted with that of French Oratorians, of Jesuits, as being Biblical, patristical, antiquarian, and documentary.

To test the truth of this view of the Benedictine mission, we cannot do better than appeal as a palmary instance to the Congregation of St. Maur, an intellectual school of Benedictines assuredly. Now what, in matter of fact, is the character of its works? It has no Malebranche, no Thomassin, no Morinus; it has no Bellarmine, no Suarez, no Petavius; it has no Tillemont or Fleury,—all of whom were more or less its contemporaries; but it has a Montfaucon, it has a Mabillon, it has a Sainte Marthe, a Coustant, a Sabbatier, a Martene,—men of immense learning and research; it has collators and publishers of MSS. and of inscriptions, editors of the text and of the versions of Holy Scripture, editors and biographers of the Fathers, antiquarians, annalists, paleographists,—with scholarship indeed, and criticism, and theological knowledge, admirable as often as elicited by the particular subject on which they are directly employed, but conspicuously subordinate to it.

Instances in point.

If we turn to other contemporary Congregations of St. Benedict we are met by the same phenomenon. Their labours have been of the same laborious, patient, tranquil kind. The first name which occurs to us is that of Augustine Calmet, of the Congregation of St. Vanne. His works are biblical and antiquarian;—a literal Comment on Scripture with Dissertations, a dictionary of the Bible, a Comment on the Benedictine Rule, a history of Lorraine. We cast our eyes round the Library, in which we happen at the moment to be writing; what Benedictine authors meet them? Their is Ceillier, also of the Congregation of St. Vanne; Bertholet, of the same Congregation; Cardinal Aguirre of Salamanca; Cressy of Douai; Pez of Mölk on the Danube; Lumper of St. George in the Hercynian Forest; Brockie of the Scotch College at Ratisbon; Reiner of the English Congregation. Their Works are of the same complexion,—historical, antiquarian, biographical, patristical,—calling to mind the line of study traditionally pursued by a modern ecclesiastical congregation, the Italian Oratory. We do not speak of Ziegelbauer, Francois, and other Benedictines, who might be added, because they have confined themselves to Benedictine Antiquities, and every order will write about itself.

Like the Italian Oratory.

Further test.

And so of the Benedictine Literature from first to last: Ziegelbauer, who has just been mentioned, has written four folio volumes on the subject. Now one of them is devoted to a catalogue and an account of Benedictine authors;—of these, those on Scripture and Positive Theology occupy 110 pages; those on history, 300; those on scholastic theology, 12; those on polemics, 12; those on moral theology, 6. This surprising contrast may be an exaggeration of the fact, because there is much of repetition and digression in his survey, and his biographical notices vary in length; but, after all allowances for such accidental unfairness in the list, the result must surely be considered as strikingly confirmatory of the account which we have been giving.

Recapitulation.

But we must cut short an investigation, which, though imperfect for the illustration of its subject, is already long for the patience of the reader. All human works are exposed to vicissitude and decay; and that the great Order of which we have been writing should in the lapse of thirteen centuries have furnished no instances of that general law, is the less to be expected, in proportion to the extent of its territory, the independence of its separate houses, and the local varieties of its constitution. To say that peace may engender selfishness, and humility become a cloak for indolence, and a country life may be an epicurean luxury, is only to enunciate the over-true maxim, that every virtue has a vice for its first cousin. *Usum non tollit abusus;* and the circumstance that Benedictine life admits of corruption into a mode of living which is not Benedictine, but its very contradictory, cannot surely be made an argument against its meritorious innocence, its resolute cheerfulness, and its strenuous tranquillity. We are told to be like little children; and where shall we find a more striking instance than is here afforded us of that union of simplicity and reverence, that clear perception of the unseen, yet recognition of the mysterious, which is the characteristic of the first years of human existence? To the monk heaven was next door; he formed no plans, he had no cares; the ravens of his father Benedict were ever at his side. He "went forth" in his youth "to his work and to his labour" until the evening of life; if he lived a day longer, he did a day's work more; whether he lived many days or few, he laboured on to the end of them. He had no wish to see further in advance of his journey, than where he was to make his next stage. He ploughed

The Benedictines unscientific and poetical,

in their course of life,

and sowed, he prayed, he meditated, he studied, he wrote, he taught, and then he died and went to heaven. He made his way into the labyrinthine forest, and he cleared just so much of space as his dwelling required, suffering the high solemn trees and the deep pathless thicket to close him in. And when he began to build, his architecture was suggested by the scene,—not the scientific and masterly conception of a great whole with many parts, as the Gothic style in a later age, but plain and inartificial, the adaptation of received fashions to his own purpose, and an addition of chapel to chapel and a wayward growth of cloister, according to the occasion, with half-concealed shrines and unexpected recesses, with paintings on the wall as by a second thought, with an absence of display and a wild, irregular beauty, like that of the woods by which he was at first surrounded. And when he would employ his mind, he turned to Scripture, the book of books, and there he found a special response to the peculiarities of his vocation; for there supernatural truths stand forth as the trees and flowers of Eden in a divine disorder, as some awful intricate garden or paradise, which he enjoyed the more because he could not catalogue its wonders. Next he read the Holy Fathers, and there again he recognized a like ungrudging profusion and careless wealth of precept and of consolation. And when he began to compose, still he did so after that mode which nature and revelation had taught him, avoiding curious knowledge, content with incidental ignorance, passing from subject to subject with little regard to system, or care to penetrate beyond his own homestead of thought,—and writing, not with the sharp logic of disputants, or the subtle analysis of philosophers, but with the one aim of reflecting in his pages, as in a faithful mirror, the words and works of the Almighty, as they confronted him, whether in Scripture and the Fathers, or in that "mighty maze" of deeds and events, which men call the world's history, but which to him was a Providential Dispensation.

In their habitat, in their architecture, in their study of Scriptures and of the Fathers, in their style of composition.

Here the beautiful character in life and death of St. Bede naturally occurs to us, who is, in his person and his writings, as truly the pattern of a Benedictine, as is St. Thomas of a Dominican; and with an extract from the letter of Cuthbert to Cuthwin concerning his last hours, which, familiarly as it is known, is always pleasant to read, we break off our subject for the present.

Instance of St. Bede,

Account of his last days.

"He was exceedingly oppressed", says Cuthbert of St. Bede, "with shortness of breathing, though without pain, before Easter Day, for about a fortnight; but he rallied, and was full of joy and gladness, and gave thanks to Almighty God day and night and every hour, up to Ascension Day; and he gave us, his scholars, daily lectures, and passed the rest of the day in singing the Psalms, and the night too in joy and thanksgiving, except the scanty time which he gave to sleep. And as soon as he woke, he was busy in his customary way, and he never ceased with uplifted hands giving thanks to God. I solemnly protest, never have I seen or heard of any one who was so diligent in thanksgiving.

"He sang that sentence of the blessed Apostle Paul, 'It is a dreadful thing to fall into the hands of the Living God', and many other passages of Scripture, in which he warned us to shake off the slumber of the soul, by anticipating our last hour. And he sang some verses of his own in English also, to the effect that no one could be too well prepared for his end, viz., in calling to mind, before he departs hence, what good or evil he has done, and how his judgment will lie. And he sang too the antiphons, of which one is, 'O King of Glory, Lord of Angels, who this day hast ascended in triumph above all the heavens, leave us not orphans, but send the promise of the Father upon us, the Spirit of Truth, alleluia'. And when he came to the words, 'leave us not orphans', he burst into tears, and wept much. He said, too, 'God scourgeth every son whom He receiveth', and, with St. Ambrose, 'I have not so lived as to be ashamed to have been among you, nor do I fear to die, for we have a good Lord'.

He works to the end.

"In those days, besides our lectures and the Psalmody, he was engaged in two works; he was translating into English the Gospel of St. John as far as the words, 'But what are these among so many', and some extracts from the *Notæ*[39] of Isidore. On the Tuesday before Ascension Day, he began to suffer still more in his breathing, and his feet were slightly swollen. However, he went through the day, dictating cheerfully, and he kept saying from time to time, 'Take down what I say quickly, for I know

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[39] The Bollandists have not been able to determine which of St. Isidore's works is here intended; it is not wonderful that we have as little succeeded in the attempt.

not how long I am to last, or whether my Maker will not take me soon'. He seemed to us to be quite aware of the time of his going, and he passed that night in giving of thanks, without sleeping. As soon as morning broke, that is on the Wednesday, he urged us to make haste with the writing which we had begun. We did so till nine o'clock, when we walked in procession with the Relics of the Saints, according to the usage of that day. But one of our party said to him, 'Dearest Master, one chapter is still wanting; can you bear our asking you about it?' He answered, 'I can bear it; take your pen and be ready, and write quickly'. At three o'clock he said to me, 'Run fast, and call our priests, that I may divide among them some little gifts which I have in my box'. When I had done this in much agitation, he spoke to each, urging and intreating them all to make a point of saying Masses and prayers for him. Thus he passed the day in joy until the evening, when the above-named youth said to him, 'Dear Master, there is yet one sentence not written'; he answered, 'Write quickly'. Presently the youth said, 'Now it is written'; he replied, 'Good, thou hast said the truth; *consummatum est;* take my head into thy hands, for it is very pleasant to me to sit facing my old praying place, and thus to call upon my Father'. And so, on the floor of his cell, he sang, 'Glory be to Father, Son, and Holy Ghost', and, just as he had said 'Holy Ghost', he breathed his last, and went to the realms above". **He dies working and giving thanks,**

It is remarkable that this flower of the Benedictine school died on the same day as St. Philip Neri,—Thursday, May 26; which in Bede's instance was Ascension Day, and in Philip's the feast of Corpus Christi. It was fitting that two saints should go to heaven together, whose mode of going thither was the same; both of them singing, praying, working, and guiding others in joy and exultation, till their very last hour. **like St. Philip Neri.**

JOHN H. NEWMAN.

[*To be continued.*]

Art. II.—*On the influence which the Physical Geography, the Animal and Vegetable Productions, etc., of different regions exert upon the Languages, Mythology, and early Literature of Mankind, with reference to its employment as a test of Ethnological Hypotheses.*

BEYOND the ordinary phenomena of organic life, stand the still more complex ones revealed to us by the contact of soul and matter. Placed upon the ever-changing surface of the globe, and composed, physically speaking, of the same materials as that globe, and affording in their arrangement the example of the greatest complexity of organization known, man must necessarily be subject to all the agencies which operate upon matter.

Physical causes influence the food, etc., of mankind,

That the different characters of the food, clothing, amusements, and tastes of different peoples, depend in a marked degree upon the climate, geographical position, and physical conformation of each country, will, we are sure, be at once conceded. So doubtless will also be the proposition, that the size, strength, colour, and the outlines of the external form of men, must in some measure be influenced by the action of surrounding nature. Might we not also add, that the diseases to which mankind is subject change in kind and in intensity within certain limits, when the physical conditions under which life is carried on are altered?

and also the operations of the mind.

The above propositions being admitted, the corollary to them,—that the operations of the mind itself must be likewise more or less influenced by the action of the physical agencies which govern the life of our bodies,—must, we think, be accepted as true. But how is this influence exerted, to what extent does it act, and how far has it operated in bringing about the phenomena recorded in the history of nations? These are among the greatest questions which can engage the attention of philosophers, alike important as the subjects of abstract science and of every-day life.

Phenomena of history the result of two sets of causes.

In the action of history, leaving out of consideration the *direct* government of Providence, we see the results of two sets of causes, of very different value it is true, but both requiring nevertheless to be carefully studied: 1. the absolute action of the mind; and 2. the disturbing action of the physical causes above mentioned. Unless the philosophic historian

can determine the amount of those disturbing causes and eliminate them, he cannot, as we think, properly discuss the relation of cause and effect in treating his subject. That this distinction of causes is but imperfectly understood by the generality of historians, we think it would be easy to show. As one example, we would merely refer to the substratum of error upon the unhappy subject of races, which underlies so much of modern history.

Proposed science of the action of physical causes upon mankind. A science of the influence of physical causes upon mankind, materially and intellectually, must obviously be based upon a knowledge of the laws of organic life. This circumstance is indeed alike the source of the great difficulty of the subject and of its imperfect development; for we cannot have much material for study when its chief fundamental science, physiology, can be scarcely said to have as yet a definite existence. We do not know whether we are justified in designating a heterogeneous mass of facts and speculations, which have never been clearly grouped into a whole, as a science. In using the word, however, we do not apply it in the sense in which we would speak of a science of chemistry or physiology, both of which are, comparatively speaking, homogeneous subjects, that is, include phenomena resulting from the operation of the same or analogous causes, but rather in the sense in which we term such a concrete subject as geology a science. Athough the latter includes physical, chemical, and physiological phenomena, and therefore not referable to the same or analogous causes, yet it is obviously convenient to group together under one head all the phenomena connected with the formation and alteration of the Earth's crust. So likewise we might group together a number of subjects which are immediately or remotely connected with the action of physical phenomena upon man, physically and intellectually. This group might consist of anthropology, or the study of the moral and physical constitution of man generally; and ethnology, or the study of the races of mankind, which we may do by two methods: *physiologically*, that is, by the physical characteristics of form of the head, colour, etc.; or *philologically*, that is, by the comparative study of languages. To these we should add such isolated subjects as the influence of physical causes on mythologies, migrations of people, forms of government and laws, industry, etc.

Materials for it. The past half century has been very prolific in materials—understanding by that term not only facts but also

speculations—for the anthropological and ethnological portions of the science. The whole literature of the other or more purely intellectual branches, consists of some passing allusions in the works of a few authors. In the construction of the science, as distinguished from the gathering of materials, there has been on the whole perhaps no very great advance made. Numerous speculations have been broached, but, with few exceptions, none of them could even serve as useful scaffolding. Nor is this to be wondered at, remembering the extreme difficulty of the whole subject, and its comparative youth among the branches of human knowledge.

Present etymological methods defective.

Few, we believe, will be disposed to deny that the present method of etymological investigation is not such as would satisfy the strict logical requirements of a scientific method. There appears to us, perhaps as the result of the defective method, a striving after the discovery of laws of the greatest possible generality before the inferior ones are established, thus anticipating the progress of the science. Considering philology as an inductive science, the general treatment of the subject is decidedly metaphysical, and the results proportionally vague and uncertain. Even the most scrupulous etymologist often analytically proves that a whole group of words has been formed from a common root, although no possible logical connection can be traced between the ideas which they symbolize. We admit that it can be historically proved that many words have been derived from a common stock, whose corresponding ideas do not exhibit the remotest relationship. Here, however, we can apply the test of history; but where we have not history to aid us, how are we to verify our analysis? for without verification the result of any analysis can only be a possibility, at best but a probability. Some material test, then, is wanted by which the fundamental results of etymological analysis may be verified.

Philological methods generally imperfect.

We have spoken chiefly of etymology in the preceding paragraph, because it is the foundation upon which the whole superstructure rests; but the imperfections are not confined to the basis. For instance, what can be more arbitrary than the principles of the classification of languages? No two philologists seem to agree about the comparative values of affinities; generic ones being frequently confounded not only with specific, but even with class affinities

Three principal causes have obviously operated in creating from the primitive mother-tongue, the great diversity of languages which now exists: 1. intellectual idiosyncrasy; 2. influence of physical agencies; 3. and mixtures and contact of peoples speaking different languages. Of these, the second is, perhaps, the most important, and the least studied, no doubt because it is the most difficult. But whatever opinion may be formed of its importance, its action certainly pervades all the phenomena of language, and must be estimated in order to establish a consistent ethnological history of languages. **Causes which produced diversity of languages.**

We are quite sensible of our unfitness to deal with this question of physical influences upon language, etc., especially with the very scanty materials which are available. The defects of plan or arrangement may pass unheeded amidst a profusion of ideas; but poverty of materials only helps to set them in stronger relief. As at best we can only treat the subject suggestively, we may do good service to science by beckoning others more qualified for the task, to enter upon a path which opens into a rich and almost virgin field of research. Trusting, then, to the indulgence of the reader, we will state what we propose to undertake. **Subject to be treated only suggestively.**

It is a well known fact that certain articulate sounds are found in one language, or group of languages, which may be wanting in another. It is also well understood that the coördination of phenomena usually leads to the detection of the laws which govern them. Why not then found a geography of articulate sounds by which we might in time discover the laws which govern their geographical distribution, and, perhaps, the solution of the problem of the origin of dialects in languages? Again, all verbs and nouns symbolize either positive material things, qualities, or actions, or did so before they became the symbols of abstract conceptions. The original stock of roots in a language must, consequently, have reflected the character of the climate, physical conformation, geological structure, and fauna and flora of the region where it originated. Among the objects for which names were framed would, doubtless, be many whose geographical distribution would be limited, and therefore determinable. In process of time also a language incorporates words from other languages by contact or fusion of the people speaking it with other nations; some of them, too, might be connected with objects having a determinate geographical position. **What we propose to do.**

If we could discover a number of such words in every language, they would constitute true ethnological fossils, by means of which we could as unerringly refer a language to its original home, and trace the line of its onward movement, as the geologist determines, by means of the remains of the plants and animals entombed in the rocks forming the external part of the Earth, the relative stratigraphical succession of those rocks.

The mythology, too, of a people, and its early poetic literature, are stamped with the character of the region where they grew up, and may, therefore, afford means, in many cases, of determining the point of departure in the migrations of a people, and even of the countries passed through, from the character of the foreign elements picked up by the way, or the traces left behind by itself. Even the course of the migration itself is subject to the influence of the physical conformation and geological structure of the surrounding regions. Finally, the same circumstances, conjointly with geographical position, determine the pursuits of nations, the development, and, to some extent, the character of their creative arts and of their social organization, while these, in turn, react upon the form of their government and their laws.

How we propose to do it.

The first two categories of our subject are pure philological problems, and their solution consequently demands the application of philological methods of investigation. Now, as our mode of treating these questions must naturally assume the form of an essay rather than of a scientific memoir, we must make the results of previous philological inquiry, to a great extent, our basis. In order to be perfectly intelligible, we must introduce the subjects, of which we have just given the programme, by a preface or brief summary of so much of the methods and results of philological ethnology as we may have occasion to refer to subsequently. After mature deliberation concerning the best and shortest method of effecting this object, we have decided upon the following: We shall take some leading ethnological hypothesis, and having first stated it in the terms of its authors, we will then briefly mention the etymological principles according to which the investigation of languages, upon which it is founded, have been conducted; the chief grammatical characteristics which serve as the basis of the classification of those languages, illustrating the latter by a short sketch of the grammatical peculiarities of the classes embraced

by the hypothesis selected, To render this part the more complete and useful for subsequent reference, we shall then enumerate the chief groups of languages comprised in those classes; and lastly, we propose to give a brief sketch of the method of historical verification applied to the same hypothesis.

All this being done, we will then be in a position to take up the questions whose discussion is our proper object. By thus grafting our subject upon some great and well recognized ethnological hypothesis, its true bearing will be better seen, while it will gain in definiteness, and our means of illustration will be more varied and interesting.

Our short-comings. However elementary we may make the summary just sketched, it must still occupy much space. With every desire to compress what we had to say into one article, we have only succeeded in bringing the "introduction" within those limits, and must consequently occupy a second article with our own speculations. But even this division has not prevented a great evil—a long article; and yet, we could not have done otherwise than make a big essay, for we have had to treat, in a few sheets, what might well require volumes to do it properly. We fear that one of the effects of our efforts at compression has been to make a kind of literary breccia, which, in order to be readable, would require to undergo complete fusion.

References to authorities. We have taken the greatest pains to give references to the original authorities for every important statement, and have even, we believe, corrected some errors which occur in this respect in several esteemed works; but still, as from the nature of such an exposition, it can only be a summary of others' labours, much that does not belong to us will be found unacknowledged, owing to having become common property. There are doubtless many very valuable works and memoirs, which might have been of use to us, which we could not procure, or of whose existence we were ignorant, a circumstance which we regret not only for our own sake, but also because it deprives us of the opportunity of doing an act of literary justice, in naming every labourer in the field.

The Indo-European Hypothesis. We shall select the "Indo-European Hypothesis", and its corollary, the "Finn Hypothesis". The former may be thus briefly stated. The greater number of European languages exhibit remarkable affinities, both verbally and grammatically, and are hence believed to

have had a common origin—that is, were derived from one mother-tongue, which existed as such at some period at or after the development of the primitive mother-tongues of the Semitic, Indo-Chinese, and other great families of languages. In Asia there are also several languages which exhibit a similar affinity, not only among one another, but also with the European ones; this affinity being in some instances stronger between an Asiatic language and an European one, than between two of the latter. The natural conclusion from all this is, that the Asiatic languages had the same mother-tongue as the European; and further, that the races speaking these allied languages are the descendents of one and the same primitive race, the seat of which has been placed in the highlands west of the Mustag and Belurtag chains, towards the Caspian Sea.[1] In this case the European races of the family must have emigrated to the westward, and the Indian ones to the south and east. This occupation of Europe and India by the same family of nations has given rise to the name Indo-European (or Indo-Germanic), by which it is distinguished.

The Finn Hypothesis.

This emigration of the Indo-European race being assumed to have taken place at a comparatively recent period to the first diffusion of mankind, the countries through which that race passed, must have been already inhabited by people of different races, and who were either absorbed, displaced, or exterminated by the immigrating one. Who were those people? History tells us that part was occupied by the Semitic races—namely, Arabia, Syria, Egypt, etc., but leaves us altogether in the dark respecting the aboriginal inhabitants of Europe and of India. It was to meet this difficulty that the Finn hypothesis was proposed; and it assumes that Finns and other allied races belonging to one great family of nations occupied all the countries with the exception of the Semitic empires, through which the Indo-European races passed. The Finns, who have thus obtained such ethnological preëminence, are, properly speaking, the race of that name forming about five-sixths of the population of the Grand Duchy of Finland, and to a smaller extent, of the Russian Government of Archangel. They are an obscure race, who, probably, have not acted any very remarkable part in history, and who appear,

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[1] Lassens, Indische Alterthümer, Bd. 1, S. 526.

almost for the first time in its pages, in the *Germania* of Tacitus,[2] whose notice is by no means flattering. Their immediate alliances are, if possible, more obscure; for among them are the Laplanders, to whom indeed it is probable the observations of Tacitus apply, rather than to the Finns of Finland. It would appear that the Laplanders once occupied all the country as far south as both shores of the Gulf of Finland, and, perhaps, even to some extent along the south shores of the Baltic.[3]

Schlözer broaches the idea.

The first person who conceived the idea of the Finn hypothesis, appears to have been Schlözer, who says:[4] "There is a Finn world or Finn stock, which, in the extent of its diffusion on the surface of the old world, is one of the very greatest in the whole history of mankind or of nations, compared to which even the Slavonic race, so far as we know its original limits, was very trifling. Take up a map and measure!—from west to east in the far north, from Finland and Lapland in Norway, the immense tracts on the coasts of the North and Arctic seas as far as the Ural; then from north to south down the west side of the Baltic sea, formerly deep into Sweden and Norway, of both which countries the Finns appear to have been the aboriginal inhabitants; then on the other side of the Baltic, through Finland Proper and Esthonia onwards to the Curische Haff; then also the whole

[2] As it may interest many of our readers, we shall give the entire passage from Tacitus:—"Peucinorum Venedorumque et Fennorum nationes Germanis an Sarmatis ascribam dubito, quamquam Peucini, quos quidam Bastarnas vocant, sermone, cultu, sede ac domiciliis ut Germani agunt. Sordes omnium ac torpor: procerum connubiis mixtis nonnihil in Sarmatarum habitum fœdantur. Venedi multum ex moribus traxerunt: nam quicquid inter Peucinos Fennosque silvarum ac montium erigitur, latrociniis pererrant. . . . . Fennis mira feritas, fœda paupertas: non arma, non equi, non Penates; victui herba, vestitui pelles, cubile humus. Sola in sagittis spes, quas, inopia ferri, ossibus asperant. Idemque venatus viros pariter ac feminas alit: passim enim comitantur partemque prædæ petunt. Nec aliud infantibus ferarum imbriumque suffugium, quam ut in aliquo ramorum nexu contegantur. Huc redeunt juvenes, hoc senum receptaculum. Sed beatius arbitrantur, quam ingemere agris, illaborare domibus, suas alienasque fortunas spe metuque versare. Securi adversus homines, securi adversus Deos, rem difficillimam assecuti sunt, ut illis ne voto quidem opus esset".—*Germania*, cap. 46.

[3] See Lehrberg's Untersuchungen über die älteste Geschichte Russlands, S. 201–203; and Sjögren über Finnische Bevölkerung des St. Petersburger Gouvernement, S. 76.

[4] Nestor, Russische Annalen, übersetzt von A. L. Schlözer. Göttingen, 1802. Th. III., S. 116–117. The passage is also quoted in Slowanské Starozitnosti sepsal Pawel Josef Šafarjk, etc., Praze, 1837". See also German Translation under the title, "Paul Joseph Schafarik's Slawische Alterthümer". Leipzig, 1843—1844".

of north-west Russia on this side of the Volga as far down as the Morduins; then beyond that great river from the Ingrians on downwards to the Voguls, Permjaks, and Bashkirs. These races still exist; they are still recognizable in their ancient languages and customs, even although most of them have been pressed forward into the far north by other different races following after them from the south; on one side the Germans, on another the Slaves, and on the third Tatars; but some few have, however, totally lost themselves in the new comers".

This idea of Schlözer was favourably received by many philologists, who successively extended it so as to include finally nearly the whole of Europe and Asia; but it is especially to Rask that the Finn hypothesis in a definite shape is due. He conjectured that the Tchudes, a name applied to the Finns and a number of allied peoples, formerly possessed the whole of modern Sweden, Norway, and Denmark.[5] He also considered that the northern family of nations, of which the Tchudic or Finnic races formed an element, had spread over a wider geographical area than any other in the world. "Thence it follows", he says,[6] "that the people of this race who are now found uninterruptedly from Greenland over the northern part of North America, Asia, and Europe as far as Finland, must have lived in very ancient times much farther into Europe;—on the one side to the Elbe, Britain, Gaul, and Spain; on the other from the White Sea to beyond the Caucasus. It would appear as if in pre-historic times, before the spread of the Indo-European race, a considerable part of the modern Europe was first occupied and for a long time inhabited by races of this family, which at a later period were partly annihilated, partly dispossessed and driven into the northern regions, by peoples of Indo-European origin—namely, by Kelts in Gaul and Britain, by Germans in Germania and Scandinavia,[7] and by Slaves

Rask's view.

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[5] Rask, Ueber die Uersprung der Altnordischen Sprachen. Stockholm, 1818, S. 112—146 (also quoted in Schafarik's Slawisch. Alterth., Bd. I. 29).

[6] Rask, in Nyerup Magazin. Kjopenhavn, 1820, I., quoted in Schafarik, who also gives Wiener Jahrb. der Liter., 1822, Bd, 15. He also mentions the title of another work of Rask's, in which allusion is made to this, but which we have not seen, namely, "Ueber die Zendsprache nebst einer Uebersicht des Gesammten Sprachstammes. Uebersetzt von F. H. v. d. Hagen" S. 69—72.

[7] Upon the supposition that *Jötunheimr*, in the Scandinavian sagas, refers to the land of the Tchudes, and Iötnar to the Tchudes themselves, Rask has attempted to prove that Jütland in Denmark [Scan-

in the Trans-Carpathian countries. The northern races also filled, as already observed, the whole of northern and middle Asia, regions which must be considered as their original home. Here the central Asiatic mountains were their shield against other races, and their immense population preserved them here from the fate which befell the smaller races belonging to the family in flat, open, everywhere accessible Europe".

The preceding passage expresses the hypothesis in its very widest extension, and we need not, therefore, dwell further on the subject, than to observe that it is the greatest conception with which the science has been enriched within the present century, and one which has undoubtedly served the chief purpose of all such speculations, namely, as scaffolding for further researches.

Basis of the Hypothesis. This hypothesis (considering the two but as one) is not a mere guess; right or wrong it is founded upon the result of comparative etymological and grammatical investigations of the languages of Europe and Asia, more or less aided by historical inquiry. The amount of truth which it contains must depend upon the correctness of the methods of research, and upon the care and skill with which they have been employed. We could not possibly describe those methods in detail, but the short sketch which we propose to give of those parts which concern our own peculiar subject, will give a sufficient idea of their general character. The points we shall notice will be: 1. the nature of roots and the formation of words; 2. the phonetic laws which govern the combinations of syllables in a language, or the gradual modification in time of the latter, or the passage of words from one language into others. These two points will require to be prefaced with some observations on the formation and classification of articulate sounds; 3. the comparative grammatical organization of different languages. In accordance with this scheme we shall now proceed to consider the formation and classification of sounds.

Production of articulate sounds. The lungs, the larynx, the mouth, and the nose are the organs used in the production of articulate speech: the aspiration, voice, and consonantal articulation are the agents. The aspiration is simply a stronger breathing which helps to give force and effect to vocal sounds, and will be best understood by the difference

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dinavian *Jotland*] derives its name from Iötnar, and that consequently the Tchudes must have formerly possessed Denmark. J. Grimm makes a similar remark, *Deutsche Mythologie*, Dritte Ausgabe, I. bd. S. 487.

between the pronunciation of *ha* and *ah*. The voice is the tone produced when the air in passing through the contracted opening of the glottis sets certain ligaments (*chordæ vocales*) in rapid vibration.

Two kinds of articulate sounds.

The sounds constituting articulate speech are of two kinds, vowels and consonants; the former are produced by the passage of the air through the opening of the glottis; the latter are formed above the glottis in the vocal tube or in the cavity of the mouth or nose, by the air simply rushing between surfaces differently modified.[8] The modifications effected in these different organs constitute what is termed articulation. If the vocal chords be relaxed, and do not consequently vibrate during the passage of the air through the glottis, we only produce the mute or whispered vowels; if the vocal chords be tense, and vibrate, we get true intonated vowel sounds, which, at the same time that they constitute elements of speech, partake somewhat of the character of musical tones. In other respects the difference in the character of vowel-sounds depends upon the size of the buccal cavity and the outlet or aperture of the mouth. All consonants, with the exception of a few modifications—or rather we should say all pure consonants—can likewise be produced in whispering without the aid of vocal intonation. Some of them, however, admit of being sounded with a vocal tone as well as without it, while we cannot so sound the others; and if we attempt to sound them aloud, we merely produce a combination of the consonant with a distinct vowel. This circumstance serves as an important element in the classification of consonants, as we shall hereafter see.

Classification of vowels.

It has been historically as well as physiologically proved, that the earliest and chief vowels were *a*, *i*, *u*; *e* and *o* having been formed later as intermediate, though nevertheless perfect, vowels—*e* lying between *a* and *i*, and *o* between *i* and *u*. Besides these perfect vowels, there are the mixed or obscure vowels, *ä*, *ö*, *ü*, resulting from the fusion of *i* with *a*, *o*, *u*. These are not diphthongs, but on the contrary may be long or short. The intermediate perfect vowels *e* and *o* have more vowel character than *i* and *u*, and hence *a*, *e*, *o*, are termed liquid or flowing vowels, and *i* and *u*, inflexible or consonantal vowels. This difference of character enables the liquid vowels to yield an infinity of delicate shades.

Value which we attach to each vowel letter.

As unfortunately the same letter is not used in every language to express the same physiological sound, it might lead to misconception if, before proceeding farther, we did not determine the precise values which we attach to each vowel letter. The chief perfect vowels, *a*, *i*, *u*, recur in all languages, and the intermediate perfect ones, *e* and *o*, in most. On this account we think

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[8] J. Müller—Elements of Physiology. Translated by Baly. London, 1843, vol. ii., p. 1046.

it more correct, when treating of languages from a scientific point of view, that each simple sound should be represented by a simple letter; that is, that the five definite physiological pure vocal sounds, produced by varying the size of the mouth aperture, etc., should be expressed by the five simple letters used in modern European alphabets for vowel sounds. This may present some difficulty at first to those who are accustomed to consider only the particular sounds which these letters represent in their own language. Thus, for example, the pure vowel sound of *a* exists in English in the *a* in *far;* of *o*, in most words in which that letter occurs. But the letters *e*, *i*, *u*, do not represent perfect vowel sounds, but mixed ones, and we have accordingly to look for the true simple vowel sounds under others; thus,—*e* will be found to be best represented by the *a* in *name; i* by the *e* in *theme;* while *u* is expressed by the *oo* in *cool.* The German *u* is the true sound, but the French and Dutch *u* are mixed sounds, the true simple sound being expressed in the former by *ou*, and in the latter by *œ.* Our *a*, *e*, *i*, etc., are, therefore, to be understood as expressing the true physiological sounds, the values of which in English we have just given. The advantage of this system will be best understood when we come to speak of diphthongs, for when we know the precise value of the simple sounds, it is easy to determine that of any possible compound.

Organs which produce consonants.

The organs of the mouth which produce articulation are the lips, tongue, and teeth, acting pair-wise in the production of consonants, one part being active, moveable, and pressing on the other; namely, the under lip, the fore part of the tongue, and the back part of the tongue, on one side, and the upper lip, teeth, and palate, on the other. The consonants differ essentially in character according as they are chiefly articulated by one or the other organ, and may accordingly be classified into *labials*, or those produced by the lips, *dentals* by the teeth, and *palatals* by the palate. Besides these, several intermediate sounds have been developed in some languages, such as the lingual or cerebral of the Sanscrit, which lie between the dentals and palatals, or, as in other languages, the labial-linguals, in the formation of which the lips act, and the glottal or guttural of many languages, which are produced lower down in the throat than the palatal. As the vibrating column of air, which produces voice, can pass through the nose as well as through the mouth, we may get nasal modifications of all the vowels and of a number of the consonants; but, as these sounds, when much developed, are disagreeable, most people avoid them, although there are some, like the sounds of *m* and *n*, and especially the latter, which cannot be produced without the intervention of the nose; indeed the former passes into *b* if we attempt to sound it by the mouth alone. The aspiration in speaking only passes through the mouth, and is of two kinds, the *spiritus lenis* and *spiritus asper.* These terms

Spiritus lenis and asper.

were first applied to the marks by which the Greeks distinguished in writing those initial vowels of words, which were to be aspirated, for they had the aspirate only at the beginning of words. Other nations distinguish the *spiritus asper* by a peculiar letter, for example, *h*, but have no mark for the *lenis*. They are both, as J. Müller says, the simplest expression of the resonance of the mouth-walls during the expiration of the air without any hindrance of the organs of the mouth. They may, therefore, be considered as the weakest and shortest explosive consonant sounds, and in this sense some writers, as for example, Rapp,[9] look upon the *spiritus lenis* as the first beginning of a consonant, and instances the circumstance that if we pronounce any vowel as *e*, tending towards the mixed vowel *ä* or *ö*, etc., we pronounce in reality two sounds; along with the fundamental vocal sound we have also the fundamental consonantal one. He even goes further, and says, that it is a law that no vowel sound can be pronounced without an accompanying consonantal one, but that none beside the fine ear of the Greeks had ever fully seized this elementary consonant, and fixed it under the name of *spiritus lenis*. Other writers[10] think that the *lenis* has only a negative character,—that it only indicates where no *asper* or true *h* aspiration occurs.

The aspirate may precede or follow the vowel, or may even completely penetrate it, and being produced by the resonance of the expired air during the repose of the vocal chords of the glottis, it ceases, that is, passes into the voice, the moment the column of air is set in vibration: aspiration and voice are therefore really inseparable.

Agents which produce consonants.

Consonantal articulation being merely the organ or instrument of speech, can only produce audible sounds by the agency of the voice or of aspiration. This circumstance introduces the new element of classification among the consonants above referred to. We have in the first place those formed through the agency of the intonation of the voice, or vocal consonants, which, if the articulation be incomplete, have a certain vowel character, and are hence called *semi-vowels*, *w*, the German and French *j*, etc. If, on the other hand, the articulation be complete, we have the *liquid consonants (Literæ consonantes liquidæ)* which are of two kinds, *oral (orales)*, *l*, *r*, and *nasal (nasales)* *m*, *n*, *ng*, etc., according as the voice escapes through the mouth or nose. If incomplete consonantal articulation be rendered audible by the aspiration or breath passing through the mouth during the aspiration itself, which can only of course be done by the organs simply approach-

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[9] Versuch einer Physiologie der Sprache. Von Dr. K. M. Rapp. 1ster Bd. 1836, S. 53.

[10] Valentin-Lehrbuch der Physiologie des Menschen (Erste Aufl. 1844), 2ter Bd., S. 291.

ing, the articulation is as it were completely penetrated by the aspiration, and we get the aspirated continuous consonants *f*, (sharp) *s* (double ss), *ch*, etc., and the mixed sounds of *s* and *ch*—*sch* in German, or English *sh*. As the half vowels, liquids, and aspirants are so formed that the voice and the breath go through the mouth or nasal canal, more or less open, while the phonetic organs do not change their place during the production of the sounds, these consonants are, like vowels, continuous sounds, and are hence termed *continuous consonants (L. c. continuæ)*. When the aspiration follows a complete articulation, which it must do in every such case, because the breath is arrested or barred for a moment by contact of the articulating organs, the *mutæ* or *mute consonants*[11] are produced. In this case the aspiration may be *spiritus lenis* or *asper*, the first giving the common inflexible consonants divided into the *soft mutes (mediæ)*, *b*, *d*, *g*, and the *hard mutes (tenues)*, *p*, *t*, *k;* the *asper* gives the *aspirated mutes* (*aspiratæ*), *bh*, *dh*, *gh* (in Sanscrit), and *ph* (φ), *th*, (θ), *kh* (χ) in Greek, Sanscrit, English, etc. The sound of the mutes is momentary, and is the result of a sudden explosion of the air forced through the organs, and more or less arrested during the articulation, and only becoming audible the moment the pressure is relieved. Hence they are called *explosive consonants (L. c. explosivæ)*. A marked distinction between explosive and continuous consonants is, that in pronouncing the former the vowel follows the consonant, in the latter it precedes it, with some trifling exceptions.

Consonants formed by the same organs, such as dentals, etc., may be called *homorganic;* but homorganism could not form the basis of a true classification of consonants, because sounds would thereby be included in the same category, which, in accordance with physiological principles, would be distinct. Some physiologists are of opinion that the production of any given sound depends less upon the accurate arrangement of particular articulating organs, than upon the fulfilment of definite physical conditions which may be expressed by a determinate geometrical figure; or, in other words, different individuals may produce the same sound by different means.[12] Consonants formed by the same kind of action may be called *homogeneous*, a character which affords the truest foundation for a classification. But although the classification of all consonants into homorganic categories be not scientifically correct, it is so within the limits of each homogeneous category. Thus there is a wide distinction between *l* and *d*, though both would be classed as dentals. A common quality of this kind is obviously not one which could form the basis of *class* distinctions. On the other hand, *l* and *r* are oral liquids, and may

Classification of consonants.

[11] So called because they do not admit of vocal intonation.

[12] Emil Harless, in the article "Stimme", in "Wagner's Handwörterbuch der Physiologie". Bd. iv. Braunschweig, 1853. S. 704.

consequently be physiologically classed together; but the former is dental, and the latter palatal, qualities, which, though not capable of founding class distinctions, are well fitted to mark generic ones. The best classification is that which includes both distinctions founded upon homogeneous and homorganic relations, the latter being subordinate to the former. In order to render this classification of consonants more intelligible, we shall give it in a tabular form, which we borrow from Heyse.[13] The letters in the same horizonal line are homogeneous, those in a perpendicular line homorganic:

A.—Continuous Consonants.	Labial.	Dental.	Palatal.
I. *Aspirants* (also Sibilants), articulation imperfect, penetrated by the aspiration (these are intimately related to the class of mute consonants),	*f*	*s* (sharp) / *ss*, *c*, etc.	*ch*
		sch (German), or *sh* English, etc.	
II. Vocal or Intonated Consonants: 1. *Semi-vowels:* Articulation imperfect, penetrated by the voice,	*w*	*s* (soft=*z*)	*j*
		French *j*, etc.	
2. *Liquids:* Articulation perfect, penetrated by the voice, which may pass either through:— *a*, the mouth producing *oral*,	—	*l*	*r*
or *b*, the nose giving *nasal*,	*m*[14]	*n*	*ng*
B.—Explosive Consonants.			
III. *Mutes:* Articulation perfect, with succeeding aspiration, 1. With *Spiritus Lenis:*— *a*, soft (*mediæ*),	*b*	*d*	*g*
b, hard (*tenues*),	*p*	*t*	*k*
2. With *Spiritus Asper*, *Aspiratæ:*— *a*, soft,	*bh*	*dh*	*gh*
b, hard,	*ph*	*th* / ϑ	*kh* / χ

Length of vowels.

A vowel being a flowing or continuous sound, may be of indefinite length if we could continue to force air through the glottis; in articulate speech it is, however, of a definite duration, the minimum being assumed as the standard.[15] As the vowels are of secondary

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[13] Die Sprachwissenschaft. S. 269.

[14] According to J. Muller (Elements of Physiology, vol. ii., p. 1047), in the pronunciation of *m*, *n*, and *ng*, the air passes simply through the nasal canal, the aperture of the mouth being closed either by the lips or by the tongue being pressed against the palate, and without suffering any opposition. The mouth is closed by the lips while *m* is spoken, but "the sound is not produced by this act of closing of the lips, but after they are closed, by the simple passage of the air through the nasal cavity, together with the resonance of the diverticulum formed by the cavity of the closed mouth". On this account he does not consider *m* to be a labial sound. This circumstance is of considerable philological importance, though the distinction does not appear to have been hitherto appreciated by philologists.

[15] If any given vowel be prolonged, as in singing, we very soon lose

importance in speech, and merely intended to sound the articulate consonant or vehicle of the ideas, the vowels of the first or primitive syllables are considered to have all been short. In the progress of development of language, the duration may be increased, partly for euphony' sake, and partly in order to express grammatical and other differences. The lengthening can, however, only take place by the junction of a new vowel element. This may or may not be identical with the first. In the first case, the result will be long vowels; in the second, diphthongs. But although the long vowel is the short vowel twice taken, it is not spoken by two successive efforts, but is one perfectly homogeneous sound of double the duration of the short one. The diphthong is also the fusion of two vowel sounds into a continuous sound; but in this case the vowels are different, and more or less of their individual character is maintained—that is, it is a heterogeneous sound unity. The mixed vowel, on the other hand, is a homogeneous one; but the diphthong often passes into it, and even into a simple long vowel. Every combination of two short vowels does not produce a true diphthong. If we arrange the vowels in the order from the highest to the deepest, thus: *i*, *e*, *a*, *o*, *u*, it will be found that the passage from the middle vowel *a*, towards *i*, on one side, and *u* on the other—that is, the combination of a flowing or initial with a fixed or final vowel alone, produces a true diphthong; the initial vowels are, accordingly, *a*, *e*, *o*, and the final *i*, *u*. The reverse arrangement does not produce the full flow; a hiatus will occur between the component vowel sounds, or the final one will pass into a half vowel *j*, and form a syllable. This contrast will be easily observed by sounding *ai*, *au*, and *ia*, *ua*. There can, consequently, be only six true diphthongs, *ai*, *au*, *ei*, *eu*, *oi*, *ou*. The false or imperfect diphthongs include all other vocal combinations of short vowels, such as *ae*, *ao*, *ea*, *eo*, *ia*, *ie*, *io*, *iu*, *ua*, *ue*, *ui*, *uo*. The first two are the links between the two classes, belonging, perhaps, as much to the true diphthongs as to the imperfect ones.

Diphthongs.

Gemination, or the doubling of consonants, corresponds to long vowels. The analogy of the diphthong among the consonants also occurs in the combination or fusion of two or more consonants; and like the diphthongs, such combinations are not arbitrary, but take place according to certain laws, that is, only certain letters can thus fuse. These laws differ according as the consonant is initial, final, or internal, that is, in the middle of the word.

Gemination.

The combination of a consonant and a vowel constitutes a syllable (συλλαβή): indeed the mere pronunciation of a conso-

The syllable.

the power of distinguishing which it is, that is, it ceases to be a true articulate sound.—Professor Willis, "*Cambridge Philosophical Transactions*", vol. iv., 1832.

nant constitutes a syllable, because it may be asserted that no consonantal sound is possible without an accompanying vowel. In Tamulic it is beautifully said, that the consonant is the body, the vowel the soul, and the syllable the soul and body. But in a more general sense, a syllable is any word, or part of a word, which is formed by a break or pause in the voice; in this way a vowel or diphthong may be considered a syllable. But it would be what is called a naked syllable; combined with one consonant, it is said to be clothed, and is *open* or *closed* according as the consonant precedes or follows the vowel; if a vowel be included between two consonants, the syllable is enclosed. It has never yet been ascertained whether all syllables were originally open; but if, as in the nature of things must be the case, the roots of all languages be monosyllabic—a result which has been obtained by analytic investigations even in the case of the highly developed languages—either this is not the case, or we have not obtained in every instance the original form of the root, for several roots occur which are enclosed syllables. In what are called the monosyllabic languages, however, open syllables appear to be the rule.

The object of every perception is perceived under two circumstances, space and time, or what we might term statical and dynamical conditions: 1. as occupying, and therefore existing in, space—therefore, a thing, an object, or a fixed quality; and 2. as changing, existing in time, and, therefore, motion, action.

First syllables expressed both nominal and verbal ideas.

The first phonetic combinations, or articulated syllables symbolic of ideas, must have expressed both conditions—statical and dynamical; that is, must have been capable of expressing the ideas represented by nouns and verbs, which together constitute the matter or substance of language. They were not, however, necessarily either nouns or verbs, but materials for both.[16] To these first rudimentary words (the ὄνομα and ῥῆμα of the Greeks, or φωναὶ σημαντικαί of Aristotle) the term root is applied. A root, or the definite articulate sound by which man first expressed his conception of any phenomenon, did not denote either the subject or the action, but the whole concrete occurrence as it affected his senses. But as the verb expresses the being, the action, the root may present itself in subsequent stages of the language in the verbal form, frequently as the infinitive, whenever the dynamic condition of the phenomenon happened to be the most important. In other cases the noun or adjective form may best express the value of the root.

The root had the

The root representing the concrete occurrence—that is, verb and subject—had the symbolic value of an entire sentence; but

[16] Bopp Vergleichende Grammatik, S. 105. W. v. Humboldt, Die Kawi Sprache (Einleitung), S. cx. Becker (Organism der Sprache, 2te neu bearbeitete Ausgabe, 1841, S. 83) is of a different opinion; he says, "All root-words in a language are verbs, and all radical conceptions, conceptions of action".

this sentence must have been very indeterminate, no fixed time being denoted; or rather it was *aoristic*, the past, present, and to some extent the future, being included. The person, like the tense, would not be expressed by any special contrivance, but the third person, which is that of narrative, would almost invariably be implied.[17]

Value of a sentence.

The idea that the roots are rather the materials for verbs and nouns, than either of them properly, receives corroboration from the study of those languages which have not yet developed themselves beyond the condition of an assemblage of roots without grammatical forms; for it is assumed that a period must have occurred in the history of the development of every language, when it consisted only of unmodified roots.[18] Thus, for example, the Chinese syllable *ta* may mean *great*, *size or greatness*, *to be great*, *to enlarge*, *very*, according to its position, combination, and relation to other words. According to K. Meyer, a similar circumstance may be observed even in such a developed language as the old Egyptian: for example, *mis mus*, the child-suckles; *him mis*, the woman bears; *mon her*, the shepherd drives; *her mon*, the driver herds.[19]

The view that roots are only materials for nouns and verbs corroborated.

A language composed wholly of roots of verbs and nouns could but imperfectly express the proportions or relations in space or time under which the subject contemplates or thinks of the object, such as number, the pronouns, beyond, down, etc., or those perfectly subjective determinations of thought, logical relations, and expressions of the will, such as affirmation, negation, doubt, question, object, cause, etc. In order to express all those complicated relations, language had to undergo certain modifications. At first the juxtaposition of certain roots with other verbal and nominal roots, would be made to express a particular relation in one position, and another in a different one, like the Chinese syllable *ta*, mentioned above. The roots which would have the value of noun and verb in a sentence made up in this way, would constitute the *matter* or *body*—the chief idea, while the roots, whose value would vary with the relative position to the chief idea, would represent the special relations of space, number, etc. This, then, would be the first stage of development of languages.

First stage of development of language.

As Fichte well observes,[20] a living language changes itself in the inverse ratio of its culture; that is, the more civilized a

[17] See J. G. Fichte, Von der Sprachfähigkeit und dem Ursprunge der Sprache—Sämmtliche Werke, Bd. viii., S 313.

[18] An opinion entertained by a great many eminent philologists, but put forward prominently by Benfey among others. Götting. Gelehrt. Anz. November, 1852, S. 1782; quoted by Heyse, Die Sprachwissenschaft, S. 144.

[19] Heyse from Münch. Gelehrt. Anz., December, 1841.

[20] Ante, Note 17.

people becomes, the less progressive change does its language undergo—the sooner does it become fossilized; the more uncultivated it is, the more the language is modified. We may accordingly expect to find that the languages of those people, who became more or less civilized at an extremely early period in the history of the human race, have been more or less checked in their development; this is the case, for example, with the Chinese. The reverse of this proposition, that a nation whose language is undeveloped must have been civilized, does not of course follow.

Second stage, or the separation of the pronominal or particle roots.

The next stage of language development would be where the roots expressing relation of time, number, etc., or what we might conveniently term form roots, would get attached or agglutinated to those constituting the matter of the sentence, and undergo more or less modification for euphony' sake, such as the loss of some letters, etc., but not so much that the original roots could not be in most cases recognized. In this stage of progression the form roots would gradually lose their original *special* meaning, and would acquire a generic one, so that a single root might be made to express the same kind of relation in connection with any number of different nouns or verbs. This loss of special meaning and gain of generic value produces in languages, at this stage of development, an essential difference between the roots which become divided into what we might term *corporal* roots, that is, nominal and verbal roots, as already mentioned, and *formal roots*, (corresponding in some measure to the ἄρθρον and σύνδεσμος of the Greeks, or φωναὶ ἄσημοι of Aristotle), or the pronominal or particle roots of comparative grammarians.

It will be observed that we have assumed all pronominal or particle roots to have originated from roots which had once verbal and nominal value. We may have assumed too much, because the opinion of philologists is yet unsettled upon this point. There are, no doubt, a great many of this class of roots, the origin of which, despite the action of agglutination, etc., can still be perfectly distinguished even in the most complex languages. Thus, to give a few examples taken at random, which although not going back to original roots, will be, perhaps, more intelligible. We have the French, *pas*, *rien*, *point*, from the original Latin substantives, *passus*, *rem*, *punctum; nihil* from *ne-hilum* (*quod granofabæ ahhæret* Festus) that is, not a fibre; *not* (Germ. *nicht*) = *ni-wiht* (*wiht* = thing); the English affix, *ly;* Anglo-Saxon, *lîk;* Old Saxon, *lîc;* Old English, *liche;* Allemannish, *li;* German *lich*—from Old High German substantive *lih* = body, form (hence German—*Leiche*, a corpse, English—*Lich*gate, the outer gate of a church-yard, *Lich*field, etc.). But it is possible that, as languages became highly symbolic, many of them might have been arbitrarily made.

Roots agglutinated or adhering together, might in process of

Third, or amalgamation stage.

time amalgamate fully together, and then gradually undergo various external phonetic modifications, that is, either destroy or alter its initial or final letters—or internal, that is, change the vowel of one of the roots, etc., so that the formal root would become so indissolubly soldered to the main word as to be unrecognizable as a distinct word. This is the amalgamate or inflexional stage of languages.

Formation of lexicographic words.

When a language becomes amalgamating or agglutinating, the primitive monosyllabic words must necessarily disappear and give place to a new set of words containing them, but modified either by internal changes or external additions. The effect of this modification is to contract the unlimited contents of the roots, and make them permanent symbols of definite conceptions, such as they would temporarily possess in a monosyllabic language, according to their relative position in a sentence. The same root might undergo a great number of modifications, so as to yield several new words, exactly as a root in the free monosyllabic condition might have represented several different ideas according to its relative position to other words. Again, the first words formed may, by the addition of the *formal* roots, give rise to a great number of words having definite grammatical forms. Thus, for example, there is assumed to be a root *flo* or *flu*, which gives the following words, some being nouns, some verbs—the root in each word being marked in Italics: English—*flo*w, *flo*od; German—*flu*ss; Latin—*flu*o, etc. From these are derived such words as *flowing*, *flooded* (probably *flower*, *floral*, *flour*), *fliessen*, *fluere*, *fluent*, etc.

Clothing and unclothing of roots.

The conversion of the root into the word, or clothing it, as we might term it, is so universal, that even in languages which border upon the monosyllabic condition, the naked root very rarely occurs, and almost every word is dissyllabled. In the modern European languages, however, which are undergoing a change which we shall notice presently, the clothing is sometimes worn off the root, and we get many naked roots having the definite meaning of former words. Thus, for example, the word *hand* was in Gothic *handus;* Crimean Gothic, *handa;* and already in Old High German it was reduced to *hant;* and in Old Saxon, Anglo-Saxon, etc., *hand* or *hond*, etc.

First method of forming words from roots

Words are formed out of roots in two ways: first, by a change of the root vowel, or internal word forming; secondly, by consonantal strengthening of the root, or external word-making. The first process may take place in three different ways: 1. by a change of the principal vowels *a*, *i*, *u*, into *e* and *o*—example, *sang*, *sing;* 2. by weakening or obscuring the root vowels *a* and *i* into *e*, and *u* into *o*, as *fall*, *fell; tan* (root), *teneo*, *tendo;* 3. by strengthening the root vowel which occurs, (*a*) by lengthening the short vowel, example λαθ (root) λήθω Doric λάθω, *făcio*, *fēci;* (*b*) by diphthonging (guna in Sanscrit) Germ. *biss*, *beissen:* φαν, φαίνω

Second method. Word-forming by the second or external process takes place by the addition of suffixes and prefixes. These additions are of three kinds: 1. Reduplication, that is, a repetition of the root itself or part of it, the effect of which is to strengthen the meaning of the root, as for example, *singsong*, *zigzag*, *.διδάσχω*. 2. Derivation, that is, by the addition of prefixes and suffixes, which, in the fully developed language, have no meaning of themselves, and do not occur isolated in the language—that is, pronominal or particle roots. The words thus derived are obtained often not directly from the root, but from some simpler word: in either case they are of two kinds, *middle forms* and *branch forms;* the former are those in which the affix is only one letter, or where the end syllable is so grown with the root or stock word, that, when the latter is stripped of the letter or syllable, it does not constitute an independent word—examples: *iron*, *water*, *finger*, *garden*, etc. The branch forms are such derivative words as leave, on removal of the prefix or affix, an intelligible word—examples: with suffix—*golden*, *potter*, *faithful*, *princess*, *darkness;* with prefix—*unripe*, *misfortune*. 3. Composition, which consists in the junction into a compound word of several simple words which independently are intelligible. Every composite word consists of two members, one of which contains the general or fundamental idea of the composite, the other limits or determines it. The fundamental word is generally placed last—as, *glasswindow*, *windowglass*, *beeswax*. Each member of a compound word may itself be compound, but this does not affect the dualistic character of the word which such compounds may form: thus, we have *fullmoonshine*, and German—*ober-landjägermeister*. The formation of compound words may take place in two ways: 1. by juxtaposition of two or more words, which stand in an immediate grammatical relationship with each other, that relationship being expressed by the usual flexions, and which together constitute a concrete whole—examples: *do-nothing*, *greater part*, etc. 2. True composition, which may be, (*a*) the junction of two or more words coming together in their simplest condition, that is, without their relations being generally expressed by flexions, and which may be decomposed again without undergoing any essential change in their meaning, such as *upperlip*, *birthday*, etc.; (*b*) by fusion, that is, the combination of the two members so as to represent a simple conception, their individual meaning, more or less altered, having passed into that of the compound, but neither of them separately having any reference to the compound, which, so far as meaning is concerned, is consequently indecomposable—examples: *penknife*, *snowwhite*, etc. Words formed by true composition being capable of holding together, may serve as materials for new compounds, or as stocks upon which to found derivative words by the addition of prefixes and suffixes—examples: *nut-tree-oil*, *fortnightly* (fourteen-night-ly).

Our observations upon articulate sounds must have shown, what indeed every one may at once divine, that the possible number of homogeneous sounds is very limited, and even of single sounds of a heterogeneous character. The combination of two sounds to an unity may, no doubt, like the mixture of two colours, produce an infinite number of shades; but as, in the case of colour mixtures, there is a limit to the appreciative power of the eye, so there is also, and a much narrower one, to that of the ear. But no one language possesses the whole even of the comparatively small number of simple sounds above mentioned, and consequently we may expect the same result in the case of the mixed sounds. This difference between the original number of sounds in any two languages must be a most fruitful cause of the production of distinct languages, quite independently of the similar effect which the differential development of the grammatical organization would have.

Number of articulate sounds limited, no language has the whole.

The most striking fundamental phenomenon of ethnological philology is the great number of distinct languages which exist. Connected with this diversity we have to notice two opinions which are at the basis of ethnological speculation. According to one, all languages have originated from one primitive one; according to the other, there have been several distinct primitive languages. Fortunately for humanity's sake, the balance of scientific evidence is decidedly in favour of the first opinion, and each new investigation but helps to clear away some remaining barrier standing in the way of an absolute harmony between religious and scientific doctrine upon this, one of the most vital questions connected with mankind. The doctrine of original unity of language involves the existence of affinities between all languages. Such affinities should also exist between all the languages derived from any one of the primitive languages; and, consequently, the observations which we are about to make fit one hypothesis as well as the other.

The two opinions about the causes of diversity of languages.

The primitive language must have first split into a small number of dialects, each of which, in its turn, may have become the parent or stock of another series, and so on. In order to compare any two languages, then, we should know the degree of relationship in which they stand, for the value of the affinities which they might exhibit would be altogether determined by it. We can best conceive the character of this relationship by comparing the whole series of languages to the members of a great family with its genealogical tree. The sons of the progenitor or father would represent the first derivations from the parent language; the children of each son would bear closer relationship to each other than they would to their cousins the children of the other sons; and so of the grand-children. But the farther we proceed the greater will be the complexity of relationships, because we may have to consider, in the case of a given

Comparative affinities of languages.

language, relationships of the same value as those represented by brother, first-cousin, second-cousin, and uncle.

Ways in which languages may differ.

This brings us to consider the several ways in which languages may differ; for it is only when we know this that we can proceed to classify them according to the relative order of their affinities. The sources of difference between languages may be thus summarized.

I. Languages undergo decay, and, consequently, single words, and even whole families founded on certain roots, and, consequently, the roots themselves, may wholly disappear out of all languages. A few derivatives may, however, escape destruction, and thus preserve the root in one or more languages, while all trace of it may have passed away out of other languages. In this state the root would be obscured. Again, a group of words may disappear, with the exception of a few derivations, out of one or more languages, but may be preserved in several others, which would thus afford a key to the root of the derivations left. We could not give examples of the first kind, because we are not sufficiently acquainted with all roots and all languages to be able to say that any one root has *positively* perished, though it is probable that numbers of them have. We can give abundant examples of the last kind of loss, but one may suffice. Engl.—*Bridegroom;* Anglo-Saxon, *Brŷdguma;* Germ.—*Bräutigam;* old high German—*Brutigomo,* from Gothic—*Guma;* Anglo-Saxon —*Guma* = old high German—*Gomo;* Lat.—*Homo* = *man;* no simple word from the same root now existing in German, while in English we have the word *Groom.* Languages grow as well as decay; this growth is, however, chiefly upon the foundation of previous words, but there is no reason to the contrary, if we assume that new roots are sometimes created.

II. Two or more languages may have complete identity of roots and of a great many simple words, and even of derivatives, but these may have been modified in sound and in meaning. This may occur in either of the following ways:—

1. In sound merely; a root or word may, in accordance with certain phonetic laws, have assumed different forms of sound in different languages.

2. By the employment of the same root or word to symbolize different ideas.

3. In both ways; that is, the original word may have been phonetically modified and its original meaning changed.

4. The same object may get its name in different languages from different roots, all of which may exist in each language. Thus, one people may derive the word blue from the colour of a lake, and another from the sky; or the word for horse from its swiftness, from its bearing burdens, or from the name of some place from whence they first obtained it, as is supposed to be the origin of the Hebrew word for that animal.

III. The same material or roots may have been subjected to different degrees or kinds of grammatical organization.

It is unnecessary just now to say anything further upon the first causes of differences between languages, the loss or gain of roots; and we shall accordingly proceed to consider the second category of causes, the most important among which, and perhaps of all causes, are phonetic modifications. Each nation, from causes not hitherto determined, use certain simple and mixed sounds in preference to others; and as different classes of articulate sounds exercise different muscles, the employment of particular sounds will help to strengthen certain muscles. On the other hand, those which would act in the production of the unused sounds, not being exercised in the same way, the faculty for producing those unused sounds will be weakened or even altogether lost. This difficulty of pronouncing foreign sounds may be still further increased by the unequal development of one of the muscles required for its production, by its constant use in pronouncing some other sound. Hence, if one language borrows a word from another, it must modify it more or less, and even to such an extent as to render it scarcely recognizable, if it contains sounds or combinations of sounds which do not exist in the language into which it is introduced.

Character of phonetic modifications.

Again, if we recollect the classification of consonants according to the organs which produce them and the manner of their production, we can understand how consonants cannot be joined with one another at random to form a syllable; or in other words, those consonants alone can be fully and purely sounded in succession as parts of one syllable, which are produced by organs and muscles which can be rapidly articulated or moved one after the other. And further, the final consonant of one syllable influences the initial one of the next in a similar manner. If the articulating organs be unable to produce the sounds in succession, they will substitute some other sound which will be naturally formed in the attempt. Even the vowel sound which accompanies certain consonants or combinations of consonants, is not an indifferent matter, and consequently it also may suffer change. The character of the modifications and substitutions which take place in this way depends upon the phonetic character of each language; or in other words, each language has phonetic laws of change of its own. From the study of these we may make a general code of phonetic laws which would enable us to include all the possible ways in which words may be phonetically modified within a limited number of categories. The more important of these general laws may be briefly summarized as follows:—

Languages change phonetically in three ways—1. by exchange of one sound for another; 2. by the addition, loss, or change of position of sound; 3. by contraction. We shall take each of these processes and examine it somewhat more in detail.

Ways in which languages

change phonetically.

I. The exchange of sounds may also take place in three ways —1. Without the apparent influence of other sounds or of the phonetic elements of the word generally, that is, where they are not the cause of the change, though they may exert a modifying influence upon the manner in which it is exerted; 2. by the action of neighbouring sounds and syllables, influence of the phonetic material—assimilation, dissimilation, and influence of phonetic equilibrium, law of compensation; 3. influence of accent.

By change of vowels.

1. *Without influence of other sounds: (a) by a change of vowels*, which usually takes place from *a*, *i*, *u*, into *e* and *o*, and of *a* into *i* and *u*; a reverse change is not considered to occur; the following example shows the kind of interchange through the whole vowel scale: German—*lache*, Italian—*lago;* English—*lake* (a=e); Latin—*lix;* Irish—*lough;* Vendish—*luza.* *(b)* by an exchange of vowels with consonants, such as the change of *i* and *u* into the half-vowels *j* and *v*, and the reverse. Another example of the same kind is the affinity which subsists in some languages between *u* and *l*, which is displayed in two ways—first, *l* becomes *u*, but it must be preceded by a vowel, for example, Latin—*collum* becomes French *cou;* secondly, a vowel preceding *l* is changed into *u;* example, Gr., ἕλκος; Latin, *ulcus.* The Latin *l* becomes *i* in Italian when it occurs between a mute and a vowel. Example, *planus*, *piano;* *clarus*, *chiaro.*

By interchange of consonants.

(*b*) *Interchange of consonants.* Consonants can only interchange when they are related to each other. This relationship is of two kinds, *homorganic*, or those produced by the same organs, such as dentals; and *homogeneous*, or those produced by the same kind of action, such as liquids, etc. This relationship is crosswise, as will be understood from what we have said on the classification of consonants; that is, two consonants may happen to be homogeneous and homorganic at the same time; as, for instance, *l* and *n:* this is, however, not common, and even in the example *l* is an oral liquid, while *n* is nasal. In accordance with this distinction, consonantal interchange may be included under two categories: 1. The interchange between homogeneous consonants, of which numerous examples might be given, between the half vowels, spirants, and *h*—Ex.: old High German, *ahsala;* middle High German, *ahsel;* modern German, *achsel;* Latin, *filum;* Spanish, *hilo;* between the liquids, such as *l* and *r*—Ex.: Lat.—*Peregrinus;* Ital.—*pelegrino;* French—*pélerin;* *l* and *n*—Ex.: Lat.—*apostolus;* French—*apôtre*, etc.; between mediæ interchange is very rare; between tenues, and finally between aspirates and spirants. 2. Interchange between homorganic consonants. Of this kind are (*a*) the interchange of continuous and explosive consonants of the same organic kind, such as *v* and *b*—Ex.: Lat., *vervex;* Middle Latin, *berbix;* French, *brebris;* *j* and *g*—Ex: German, *Gemse;* Polish, *Giemza;* *h*, *ch* (χ), and *g*—Ex.: Gothic, *Guma;* Old High German, *gomo (komo);* Latin, *homo;*

d and *t* into *s*—Ex.: Greek, ῥόδον; Latin *Rosa; l* and *d; m, b, p*—Ex.: Gothic, *stibna;* old English, *stempne;* old Saxon, *stemna;* German, *stimme.* 2. The interchange of the homorganic labial-mutes *b, p,* etc.; dental, *d, t, th,* etc.; palatal, *g, k,* etc. Interchanges of this kind between homorganic mutes are so common that every one can suggest an example. Connected with the interchange of homorganic mutes, we may mention the remarkable historical interchange which has been discovered among the Indo-European languages, and which exhibits a perfect circular movement from one articulation stage to another, in accordance with the law of *transposition of sounds* (in German, *Lautverschiebung*) discovered by Jacob Grimm.[21] The Greek, Latin, and Sanscrit form one stage; the Gothic, Old Saxon, Anglo-Saxon, the Scandinavian languages, and the Lower German, the second; the old High German, the third stage. According to these successive stages, each of the nine mutes has been shifted forward in the direction in which the sounds are naturally developed—that is, the labial, dental, and palatal mediæ pass into the corresponding tenues, the latter into aspirates, and aspirates into mediæ again, thus completing the circle.[22] The middle and modern High German have remained nearly at the third stage, or that of the old High German, with, however, an increasing tendency towards a retrograde movement, that is, to soften the hard consonants, the former movement being a passage from soft to hard sounds.

Grimm's law of transposition.

The following table will help to render this very remarkable law more intelligible. The letters are arranged in three *homorganic* categories of labials, dentals, and palatals. The first column in each division serves to show to what homogeneous category the letters in the division belong. The second column gives the three Greek mutes belonging to each homorganic division; the third, the corresponding ones in Gothic; and the fourth, in old High German. Thus *b* in Greek corresponds to *p* in Gothic and to *f* in German, while *ph* in Greek is represented by *b* in Gothic and *p* in German—that is, the Greek mediæ become Gothic tenuis and German aspirates, etc. If we take any given letter in any of the languages named, we may, by this table, find the corresponding letters in any of the others; thus, *t* in old High German corresponds to Gothic *d*, etc.

Labials.				Dentals.				Palatals.			
	Greek.	Gothic.	Old H. German.		Greek.	Gothic.	Old H. German.		Greek.	Gothic.	Old H. German.
Mediæ *b*	*b*	*p*	*f*	Mediæ *d*	*d*	t	th	Mediæ *g*	*g*	*k*	*kh*
Tenuis *p*	*p*	*f*	*b*	Tenuis *t*	*t*	th	d	Tenuis *k*	*k*	*kh*	*g*
Aspirate {ph, f}	*ph*	*b*	*p*	Aspirate *th*	*th*	d	t	Aspirate *kh*	*kh*	*g*	*k*

[21] Deutsche Grammatik, I. S. 581.

[22] See J. Grimm, Geschichte d. Deutschen Sprache, S. 393; also Heyse, Sprachwissenschaft, S. 306.

2. *Under the Influence of Neighbouring Sounds.* Changes of this kind may be classed under two categories, 1. those depending upon the material *quality* of the sound; and 2. upon the quantity or equilibrium of the syllable. The first category may be further subdivided into, 1. assimilation of consonants and vowels; and 2. dissimilation.

Assimilation of consonants.

Assimilation is of two kinds, *homologous* and *analogous*, and may be either consonantal or vocal, progressive or retrogressive; generally it is the latter in the Indo-European languages, the speech going forward and anticipating, as it were, the following sound; but in the northern or Ural-Altaic languages, vocal assimilation is always progressive, the vowel of the affix being made dependent upon that of the root. 1. Homologous assimilation, or the assimilation of a liquid to a preceding liquid, or a labial, a preceding labial, and so on. Thus, in Greek σ assimilates ν in σὺν and πάλιν when they enter into combination; *e. g.*, σύσσιτοι, παλίσσυτος. Again, we have in Latin an example of a mute assimilating a mute when *ad*, *sub*, and *ob*, enter into combination; *e.g.*, *affinis*, *succedo*, *oppono*. This kind of assimilation is also common in the conversion of Latin words into Italian, thus: *dictus*=*detto*. The assimilating influence of l in the middle of a word upon a preceding ᴅ in Irish, may be referred to this category, thus: coᴅla sleep, is pronounced as if written colla. 2. Analogous assimilation, which is of two kinds; (*a*) homorganic, or the conversion of a consonant into another which belongs to the same organ as the following one, thus: *tam* gives *tandem*; that is, the labial *m* passes into the dental, to correspond to the dental *d*; French, *printemp*=Latin, *primum tempus*; Italian, *pronto*= Latin, *promptus*. (*b*) Homogeneous, or the conversion of a consonant into another which belongs to the same stage of articulation. This is the law in Greek for all combinations of two mutes; thus the soft labial β in τρίβω is hardened to the tennis π, when in combination it is succeeded by the hard dental τ in τέτριπται. Again, the spirant *s* hardens the preceding media, *scribo*—*scripsi*; liquids, on the other hand, soften; thus, the hard *t* in *quatuor* is softened to *d* by the liquid *r* in *quadrupes*, etc. To this category belongs also the kind of assimilation called by Schleicher,[23]

Zetacismus.

Zetacismus, which occurs in almost every language—namely, the action of *i* or *j* on a preceding *k* or *t* sound; in assimilating these it, as it were, squeezes them, and gives a hissing sound.[24] Assi-

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[23] Sprachvergleichende Untersuchungen, S. 33.

[24] The Hellenic substitution of the palatal sibilant ζ for the softened guttural and dental consonants of the ancient dialects, is of this kind. The English *g*, *j*, and *ch*, are also more or less the result of the same kind of action. The palatal sibilants resulting from Zetacismus are distinct from the original sibilants of the language, inasmuch as at the very period when the latter are fading into mere aspirations, or degenerating into semi-vowels, the process of substituting palatal sibilants may be in full activity.

milation extends also outside the limits of words, to the contiguous sounds of connected words, in the pronunciation of many peoples, and even to the written language, as was especially the case in Sanscrit.

Assimilation of vowels.

The assimilation of vowels differs so far from that of consonants, that, while the latter is almost invariably the result of contact of two sounds, in the former the vowel of a syllable acts upon that of the preceding syllable over the intermediate consonants. As examples of homologous assimilation, we may instance *nihil=ne hilum*, *consul=consilium*. The analogous assimilation of vowels may be described as the obscuring of the vowel of a preceding syllable, mixing with it another vowel sound. Of this kind is the remarkable progressive vowel assimilation in the Finnic-Tatarian or northern family of languages. According to the peculiar vocal harmony in these languages, a final *a*, *o*, *u*, becomes *ä*, *ö*, *ü*, if the root vowel be *ä*, *ö*, *ü*, and *vice versa*. The Irish rule of "Broad to broad, slender to slender", caol le caol agus leaṫan le leaṫan, is very similar to the law of harmony just mentioned. In Irish the vowels are classified into broad (*a*, *o*, *u*,) and slender (*e*, *i*). Now, the rule is this, that a consonant or consonants should, in every written word, lie between either two broad or two slender vowels; or, in other words, if the vowel of a syllable be broad, the vowel of the next succeeding syllable should be broad; if a slender vowel preceded, a slender one should follow.

Dissimilation.

Dissimilation is the avoidance of the disagreeable repetition of like sounds by the conversion of homogeneous consonants into heterogeneous, and homorganic into heterorganic. For instance, the Greeks never commenced two succeeding syllables with aspirates; if in combination this happens, the first aspirate is converted into the tenuis homorganic with it. Indeed they appear to have avoided having the same consonant occur in two successive syllables. A remarkable example of dissimilation is afforded by the euphoneous interchange between the palatal liquid *r* and the dental one *l* in the Latin words ending in *aris* or *alis*. If the simple word or stock upon which the derivation is effected end in *r*, the termination will be *alis*; if in *l*, in *aris*. Examples: *singularis*, *muralis*, *Solaris*. In English we have *purple*, from Latin *purpura*; *marble*—French, *marbre*, from Latin *marmor*.

Laws of Compensation.

Equilibrium of Sentences, or the Laws of Compensation.—In assimilation and dissimilation we have the establishment of euphony by means of a positive change of quality in the sounds themselves. In the laws of compensation we have a much more delicate method of attaining it in certain cases, by the relation between the quantity or length of the vowel sounds in connected syllables. Vowel changes of this kind may be purely phonetic, or, without having any positive grammatical value, may affect the symbolic meaning of a syllable by giving it phonetic preëminence.

The effect may be produced in two ways, by strengthening the vowel sounds, or by weakening them. The former consists in the diphthonging or lengthening of the short root vowels;[25] the latter in the weakening of the stock vowel when it is increased by reduplication or prefix. Thus in Latin, *ă* becomes *ĭ* in open syllables, and *e* in closed ones; *facio*, *efficio*; *annus*, *perennis*. In certain cases *a* passes into *u*; *ĕ* into *ĭ*; *ae* into *ī*; *au* into *ū*; *ō* into *ĭ*; *ū* into *ĕ*, etc.; some of these changes being common to a great many languages, while others are peculiar to one.

Influence of accent.

3. *Under the influence of accent.*—The relative importance of this element of phonetic change depends upon the circumstance of its being fixed or variable. In Greek and Latin it was variable, and followed or depended upon the number of syllables in the word, or the quantity, which was almost always invariable. In modern languages there is a gradual tendency to make words purely symbolic, and hence in some of them accent is employed not only as a means for obtaining pure euphony, but to express intellectual differences, as a kind of delicate substitute for inflexions cast off. In such cases it overrides all other phonetic relations, altering the pronunciation of both toned and untoned syllables. Thus, for example, in German the tone or accent is quite invariable, always maintaining its position on the root or stock syllable; such toned or accented syllables have their short vowels lengthened, or the following consonant doubled; the vowels in the unaccented syllables being weakened or even volatilized altogether.

II. Augmentation, Retrenchment, Metathesis.—These phonetic means of change are presented to us under two aspects, either in their evident or historical form, as they have been presented to us in the gradual change of a given language in the course of time, or in the contrast of allied languages or dialects of the same stock, or as the expression of the assumed methods according to which grammarians suppose certain phonetic changes to have occurred either in the formation of the simple words or inflexions.

Augmentation.

Augmentation is applied to the addition of meaningless sounds to words in order to establish euphony, and takes place either by (*a*) Prosthesis or Prothesis, or the prefixing of a letter: thus Lat., *spiritus*; French, *esprit*. It may be a consonant as well as a vowel. Anglo-Saxon, *meltan* (English—*melt*) gives English *smelt*, old German *smeltan*, modern German *schmelzen*. (*b*) Epithesis, or augmentation by a final letter, such as the ν of the third person singular in Greek, τέτυφεν; (*c*) Epenthesis, or augmentation by

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[25] This is the Guna and Wriddhi of Sanscrit grammarians: the former consists in adding an *ă* before the vowel, so that from *i* or *u* *ē* or *ō* is obtained. Wriddhi consists in the use of *ă* in the same way, so that *ā* before *i* gives *ai*; *ā* before *u* gives au. Heyse Sprachwissenschaft, S. 316.

interpolation of sounds in the interior of the word. Example, of a consonant, Lat. *domitare*—French, *dompter;* of a vowel—Gr. Ἀσκληπιός —Lat. *Æsculapius.*

Retrenchment is rarely employed to produce euphony, but rather for brevity, and is one of the principal causes of the difficulty of discovering the roots in some languages, as in French. It takes place either by (*a*) Aphæresis, or the retrenchment of a vowel or consonant in the first syllable. Example, Lat. *extraneus*, Ital. *estraneo;* French, *é(s)tranger*, Engl. *stranger.* The French word is an example of the retrenchment of a consonant, the English of a vowel; (*b*) Apokope, or the cutting off final vowels and consonants. The latter is common in Greek, such, for example, as the dropping of final mutes; the former is not, but very frequent in other languages. Sometimes the whole syllable is cut off, Latin, *Amicus*—French, *Ami.* (*c*) Retrenchment in the interior of a word, which may be, 1. elision, or the dropping of one vowel when two come together, as *ne—unquam = nunquam;* 2. syncope, or the dropping of a vowel occurring between two consonants. Example, πατήρ—πατρός; Lat. *valide—valde.* Sometimes it causes the melting of two words. Example, *do not*, *do'nt;* (*c*) dropping of a consonant or of a whole syllable or eclipsis. When this takes place in the case of a consonant and two vowels, the latter are drawn together, and a long vowel produced, if the two vowels be alike, or a diphthong, if they be different. We need not give examples of this kind of change, as they are abundant in every language, and in most cases the rules vary with the language. Retrenchment.

Metathesis, or the reversal or changing about of the position of a sound with respect to the other sounds of a word. It is one of the commonest and most important methods of changing the appearance of words, and producing difference between allied languages. Examples: Latin, *pro;* Spanish, *por;* French, *pour;* Gothic, *brinnan, brennan;* Anglo-Saxon, *birnan;* English, *burn;* Anglo-Saxon, *thridda;* English, *third.* The tendency in the modern languages is to transfer the consonant after the vowel, as in the examples given; but in the Slavonic dialects the tendency is the reverse, at least in the case of the liquids. Metathesis.

III. Contraction is the combination or fusion of two or more vowels belonging to different syllables, to a single mixed vowel or diphthong. In some languages this is effected only for euphony, in others its object is brevity. As the simple vowels are all preserved in the compound one, and are not lost, as in the case of actual retrenchment, the effect of this method of change is not nearly so destructive of the organic form of the language as those already mentioned. Contraction may be imperfect or perfect; the former is only employed in the pronunciation, the latter being also employed in writing. Imperfect contraction is of two kinds: Synizesis, or the combination of two vowels in pronun- Contraction.

ciation to a diphthong; and Synalœpha, or the melting of two vowels to one mixed vowel, which needs not necessarily be long. They are both temporary means of helping rhythm, and their only permanent effect is dependent upon what the early rhythmical ballads of a people may have upon its ultimate pronunciation.

Perfect contraction is of two kinds: contraction properly so called (*συναίρεσις*), which takes place within a word, or between two separate words, or crasis which is almost confined to Greek.

All the chief letter-changes come under the foregoing categories.

All, or nearly all, possible modes of word forming and letter changing, which could exist in any language, may, we believe, be included under some one or more of the categories mentioned in the preceding abstract. If the changes of this kind, which every language admits of, be determined, the comparative philologist is also able to discover the special phonetic laws which belong to each language. Having discovered these, he may now proceed to analyze the words of any language, decompose the compound ones into their component ones, strip the derivatives from a common stock word of their inflexional elements, and unclothe the stock itself so as to obtain the naked root: he may even in many cases discover the roots of the inflexional elements themselves. Again, he may proceed synthetically as well as analytically: knowing the modification which a simple word or root would undergo on being subjected to the action of the peculiar phonetic laws of a language, or of a series of languages, singly or in succession, he may test the accuracy of his analytical results, by building upon one of his roots all the words which it might form in accordance to the phonetic and formalistic or grammatical laws of a given language, and then see how far his backword process accords with the actual words in that language. This synthetical test has never, as it ought to have been, applied to the whole series of roots of a family of languages, and the artificial materials for a lexicon thus formed, compared with those which the natural growth of the language had evolved.

What the discovery of the peculiar phonetic laws of each language enables us to do.

Etymological researches not based upon phonetic laws, of no value.

It must be evident that any attempt at etymological investigation, not founded on a knowledge of the phonetic laws of languages, must be perfectly barren in result. We admit that the results hitherto obtained by the phonetic system are not above suspicion; nay, more, we confess that acknowledged adepts in the processes of letter changing have arrived at the strangest results, such even as the wildest etymological guesses of the old school of

philologists could scarcely rival certainly never excel. All this merely proves that a good instrument has been badly applied, and that philology is yet in its infancy as an inductive science.

Having disposed of the phonetic laws, the basis of all branches of comparative grammar, we can now address ourselves to the last element of difference between languages—grammatical organization. The special object which we have in view in this essay dispenses us from dwelling with the same detail upon this element of difference that we did upon the phonetic one. It would not, indeed, be necessary in any case, inasmuch as every one is more or less acquainted with the elements of grammar, while the principles of letter-changes are comparatively but little known. When we speak of grammatical organization, we mean it chiefly in reference to the formation of grammatical words (adjectives, adverbs), inflexions, etc.; because, strictly speaking, all we have said about roots and words belongs to the subject of grammar, just as much as anything we shall hereafter say; but the distinction, without being logical, is convenient. We shall have to make a few observations on the classification of languages in connection with the Indo-European and Finn Hypotheses, and this will offer us an opportunity of communicating as much information on this part of comparative grammar as will suit the purpose we have in view.

Difference between languages in grammatical organization.

Bacon's aphorism, "*Citius emergit veritas ex errore quam ex confusione*", however we may be disposed to doubt of its truth universally, is quite applicable to the case of sciences which deal with a multitude of objects or facts. Better some classification, even though erroneous, than none at all, because we may safely say that one of the greatest progressive steps which an infant science can make is the framing of some classification. In the infancy of science the classification must needs be artificial, because the affinities linking the objects or facts cannot be known, much less can their order or relative value. One of the uses, indeed, of a system of classification, is to enable affinities to be discovered. The most artificial classification ever proposed contained some elements of a natural one; but a perfectly natural one can only be framed at a very advanced stage of the science. There can be no doubt then that there is some truth, indeed much, in the recent classifications of languages proposed by several distinguished German philologists; nevertheless, they are

Classification indispensable.

but temporary scaffolding, and should never be looked upon in any other light. Of all those which have been proposed, that of Pott appears to present most advantages, with one exception, which we shall hereafter refer to, than any of the others. This classification may be thus summarized: 1. *Isolating languages*, or those in which the matter or chief idea, and the form, or secondary idea, derivative or flexional element, still remain perfectly separated. 2. *Agglutinating languages*, wherein matter and form adhere together, but scarcely more than externally. 3. *True inflexional amalgamating languages*, in which the matter and form are so intimately blended that both fuse into an indecomposable unity. The first class is represented by the Chinese and Indo-Chinese languages; the second, by the Finnish, Turkish, Mongolian, and other languages grouped together in accordance with the Finn hypothesis; the third, by the Semitic, and still more so by the Indo-European languages. The latter is the proper normal type; the first two are below the normal; but there are others again which Pott considers to exceed the normal, namely, the American; and accordingly he makes a fourth class of them;—4. The transnormal or *incorporating languages*.

Pott's classification.

F. Schlegel's.

F. Schlegel, who was one of the first to make a general classification of languages, divided[26] them into three principal classes: *flexionless*, *affixing*, and *inflecting* languages. A. W. Schlegel[27] adopted his brother's classification, but subdivided the inflecting languages into *synthetical*, or those whose inflexions are chiefly formed by additions to the root or stock word, and *analytical*, or those which can also make internal phonetic changes in the root or stock word perform the functions of inflections. The Indo-European represent the synthetical languages; the Semitic (Hebrew, etc), the analytical. Bopp[28] has made another classification, in which he starts from the mechanism of the languages—that is, the means by which their grammar is formed, and accordingly distinguishes the following classes: 1. Languages with monosyllabic roots, without the power of combination, and, therefore, without organization, without grammar; of which the

A. W. Schlegel's.

[26] See his celebrated work, "Ueber die Sprache und Weisheit der Inder".

[27] "Observations sur la langue et la literature Provençales".

[28] Vergleichende Grammatik, s. 112.

Chinese is the type. 2. Languages with monosyllabic roots, but capable of combination, and developing their organization or grammar almost wholly in this way; of which Sanscrit, Greek, and all other languages (whether agglutinating or amalgamating), with the exception of, 3. the Semitic languages, which produce their grammatical forms not only by combination, but also by internal change in the root itself. W. v. Humboldt,[29] though making the external form or grammatical structure of languages the basis of his classification, seems to have been influenced also by what we might term the comparative psychological character of languages. He takes two extreme opposite types—the Chinese and Sanscrit (Indo-European) languages, the former having no phonetic expressions whatever for grammatical differences, while the latter express them in the most perfect manner by true inflections. All other languages lie between these extremes, and admit, in general, of being only negatively characterized; while, on the one hand, they are capable of expressing some grammatical relations, they do not possess true inflections; hence they can only be included together in one class upon very general and indefinite grounds. The grammatical differences in this very loosely formed class are, however, distinguished, so far as external form or material expression is concerned, very clearly and sharply, by particles or *formal* words, which are themselves either complete words or can be directly referred to such, and, consequently, have an independent meaning. But, on the other hand, they do not possess any invariable, inherent *formalistic* or grammatical difference between noun and verb, so that it often happens that any word may be used as a verb or noun indifferently. This would show, in accordance with what we have already said upon the subject of roots, that the words in these languages have not yet lost the intrinsic character of primitive roots, that is, are rather materials for nouns or verbs than either of them properly. Humboldt divides this class of languages into two groups, according to the mode in which the particles are employed: (*a*) *Particle languages*, properly so called, which do not characterize the verb by any external form, like the Indo-Chinese and the Polynesian languages. To this class he also

W. von Humboldt's.

[29] See the Introduction to his great work, "Die Kawi Sprache".

adds the Mandchu and Mongolian, but this, we believe, he did upon imperfect data. 2. *Agglutinating languages*, which characterize the verb more or less perfectly by pronominal suffixes, shortened or modified in form. In accordance with this classification, the Chinese, as being more consequent, would stand higher than the whole class, which is characterized by a want of true logical consequence, the grammatical spirit having been obscured by mixing the material and formal meaning together.

Steinthal's.

Steinthal[30] has proposed another classification not founded, like all the preceding ones, upon the external form or mechanism of the languages, but on the specifically different internal feeling or power of languages of different peoples, and the internal form of speech thereby developed. The fundamental idea of Steinthal's classification appears to involve the admission of several distinct races of men, while all the others are consistent with unity of race, or actually assume it.

Languages drop their inflexions.

Inflected languages have within historical times undergone a singular change, which has resulted in the production of what might be considered as a perfectly distinct class of languages. This change is the falling off of the inflections, or their incorporation in some instances with the body of the word, losing at the same time their inflectional value, the functions of the lost inflections being then fulfilled by separate words,—prepositions with substantives, and auxiliaries with verbs. The English, French, Italian, modern Greek, the Germanic, and other modern European languages, etc., are now in this condition. They also exhibit a great instability in the manner of expressing relations of time, that is, the tenses, and even in the employment of the conditional forms of verbs. Navratil,[31] for example, has drawn attention to a singular circumstance of this kind in some of the Sclavonic languages. They are especially distinguished from other languages by a distinction between verbs depending upon the duration of the action—that is, into imperfect verbs

Change which Sclavonic verbs are undergoing.

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[30] Die Classification der Sprachen dargestellt als die Entwicklung der Sprachidee; Berlin, 1850—and Die Entwicklung der Schrift. Nebst einem offenen Sendschreiben an Herrn—Prof. Pott., Berlin, 1852. We have not had an opportunity of seeing either of these works, and are consequently able to judge of them only from a few extracts in Böhtlingks "Ueber die Sprache der Jakuten. St. Petersburg, 1851", and a reference to them in Heyse's "Die Sprachwissenschaft".

[31] Beitrag zum Studium des Slavischen Zeitwortes aller Dialekte Wien, 1856.

(*verba imperfectiva*), which express imperfect action, and perfect verbs (*verba perfectiva*), which express finished, completed action. By means of this distinction the Sclavonic dialects are able to express by a single form an action once performed, for the repetition of individual actions, or the action as a whole, and thus gain in precision and shortness of expression. Logically speaking, the perfect verb can have no present indicative; the imperfect verb, on the other hand, expressing action in process, can alone have a true present tense. Now, the change alluded to is the use of the present indicative of the perfect verb to express the true present. The effect of this tendency is to obliterate the imperfect verbs altogether. Such changes are more marked and rapid in the dialects of mixed peoples.

It may be useful here to point out some of the more prominent peculiarities of each of the great families into which philologists are disposed to divide languages. And we may observe, that these divisions exhibit in some cases remarkable coincidences with the geographical divisions of continents.

Development of alphabetic writing.

Alphabetic writing, as Dr. Donaldson has observed, was not invented by one effort. It was the result of a series of successive improvements. The first effort at assisting the memory must have been a rude drawing of the object; but such drawing must have had from the outset more or less symbolic meaning, as representing a quality or an action; for example, a rude outline of a horse, swiftness. It then became ideographic, the idea being directly suggested by the picture. Such was the Egyptian picture-writing in its earliest stage. For, as Champollion's important discovery shows, these ideographic symbols very soon became phonographic; the latter element never, however, becoming predominant. Out of the Egyptian ideographic writing was evolved the purely phonographic Hebrew letter alphabet, which was probably the parent of all other letter alphabets invented. In China the process of evolution was different. Instead of ideographic symbols, when they lost the power of pictorial representation, becoming phonographic symbols, as the Egyptian did, they merely became purely abstract symbols, like numerals (as Latham calls them, rhæmatographic), whose combinations expressed complex ideas, without any reference to the form of objects. In Chinese there are about 200 such simple signs, which have been de-

rived originally from pictures of objects; out of these some 40,000 to 50,000 combinations can be made (the Imperial Dictionary contains about 33,000). The Chinese ideographic symbols have also their phonographic derivative in the Japanese; but this is a syllable alphabet, and not a letter one. Now Chinese writing expresses perfectly the character of the language; the monosyllabic roots are, in truth, abstract rhæmatographic sounds, which have no separate special meaning, and only acquire it in combination.

Accentuation in monosyllabic languages.

A monosyllabic language cannot have the syllabic accentuation of polysyllabic languages; but, in lieu of it, the Chinese has a very peculiar syllable tone, which belongs more to the character of the idea symbolized than to the sound itself, and is, consequently, of importance for the meaning of the word. This accent is not a mere emphasis, but a positive rise and fall of the voice, productive of a kind of musical intonation. This circumstance is of considerable ethnological importance, inasmuch as it seems very probable that accent was originally in all languages a musical intonation of this kind. Very recently, indeed, Weil and Benlöw[32] have endeavoured to prove that this was the case in Sanscrit and Greek, and, to a certain extent, in Latin also, and consequently in the mother-tongue of the Indo-European languages. We shall have occasion to refer to this subject again.

Character of American languages.

While the Chinese is characteristically monosyllabic, the American languages are apparently polysyllabic. The elements of a sentence, which in the Chinese are placed side by side without combination, are phonetically fused in the American languages, so as to become one word. As they have not attained a single trace of inflexions, or any more grammatical organization than the Chinese, they are polysynthetical rather than polysyllabic, and ought, strictly speaking, be classed with the Indo-Chinese family. The difference between them and the Chinese is more apparent than real, or, as Steinthal has well observed, purely morphological.[33] William von Humboldt[34] has termed one of them, the Mexican, *incorporating*, because it places the object between the subject and verb, as for examples—*ni-qua*, I eat; *ni-naca-qua*, I flesh

[32] Théorie Générale de l'Accentuation Latine.

[33] Die Classification der Sprachen. Quoted in Heyse's Sprachwissenschaft, S. 175.

[43] Die Kawi Sprache—Einleitung.

eat; *ni-maca*, I give; *ni-te-tla-maca*, I-some-one-something-give. The close and striking affinity, or rather the absence of all intrinsic difference, between the American and Chinese languages, becomes remarkably evident, as Heyse observes, when, in Mexican, the elements of a sentence are too numerous to be fused into one word. In this case they fall asunder, and stand beside one another as indifferently as in Chinese; as the following example, from the work of Humboldt, already quoted, shows:—*ni-c-tschihui-eia in no-piltzen ce calli*=I-it make-for the my-son a house=I make for my son a house. Pott applied Humboldt's term *incorporating*, as we have seen, to the whole American languages, and made them a distinct family. While he considers the Chinese under the normal, he makes the American transnormal; it is difficult to understand what he means by this term; because the American languages certainly never passed beyond the monosyllabic stage in the direction of the normal type. Future researches will undoubtedly show that the American languages only form a subdivision of the Indo-Chinese family; that is, that they belong to the family of monosyllabic languages of which the Chinese is the highest type, and which includes the Siamese and other languages of farther India.

Character of Malayan.

The Malayan is another family intimately connected with the Chinese. The languages of this family are spread over the Phillippine Islands, Sumatra, Java, Borneo, Celebes, Madagascar, and the peninsula of Malacca, forming the western branch, or Malay Proper, and the Polynesian Islands, or the eastern branch. The words are monosyllabic, and consist of the naked roots, inasmuch as any word may be used indifferently, as substantive, adjective, or verb. The grammatical relations in the eastern branch, as in the Indo-Chinese, are expressed by the position of the words, and by separate particles; or, in other words, it has no grammar. The Malay, in the stricter sense, without having a true grammar, exhibits a tendency to form words by the addition of prefixes, affixes, etc. Considering Chinese as the type, we have one great family of languages, consisting of three great groups, the Indo-Chinese, the American, and the Malay-Polynesian. The latter, it may be remarked, is very much mixed up with Sanscrit elements in those places geographically situate near India; this is the case with the Kawi, or poetical language of Java. It was this intimate

mixture that led Bopp to consider the Malayan languages as disintegrated Sanscrit dialects. One of the greatest problems in philology would unquestionably be the investigation of the roots of all the languages of the three groups here mentioned, with the view of establishing their identity. The time is, however, distant when a solution of so vast a problem can be hoped for.

Northern or Altaic-Uralian family. Conterminous, northward and westward, with the last named great family, come a multitude of languages spoken by nations, which occupy the whole of central and northern Asia, from the Pacific to Europe, and even part of Europe itself. These languages exhibit sufficient affinities to entitle philologists to connect them together into one family. The limits of an article, and the object we have in view, forbid us to enter into any details as to the nature of those affinities; but as this is the northern family, already mentioned in connection with the Finn hypothesis, we may find it useful, subsequently, to note somewhat more specially than in the case of the last group of families, the kind of general affinities by which the members of the family are linked together.

Progressive grammatical development in going from east to west. This family exhibits a remarkable development in grammatical organization as we proceed from east to west. The Mandchu, which is conterminous with the Chinese, exhibits the first development of the agglutinating stage of languages, but was congealed in its very infancy; while in Finnish and Hungarian, the most extreme western members, we have two languages which approach so closely to the European type, that many are disposed to take them, especially Finnish, out of the class altogether, and join them to the Indo-European. **Family divides itself into two divisions.** The family thus naturally divides itself into two divisions:—the eastern—Mandchu (Tungus) and Mongolian; the western—Turkish and Finnish languages. Between them come the Samojede group, which in some respects belongs to the first. The language of the first division can scarcely be said to have any true grammatical categories, there being frequently no absolute distinction between adjectives and verbs. **Character of first division.** Thus, in Samojede, the adjective, when used as an attribute, has the meaning of a noun, as *sawa jâle*, a good day; but if it be used as a predicate, it acquires a verbal character, as the conjunction is at the same time contained in it, as *jâleda sawa*, the day is good. It may also get an adverbial significance. Similarly, the substantive may be a nominal or verbal stock at the same time,

This absence of distinct grammatical categories goes so far in the Samojede, that a noun may be both declined and conjugated, the latter not extending, however, beyond the indicative mood; still in this mood the personal suffixes of the noun and verb are not completely different. The verbal suffixes can not only be affixed to the nominative, but even to the other cases. Possessive suffixes may be added to nouns, as *anou*, my boat; but in some dialects this may be likewise added to verbs, so that the two kinds of suffixes are common to nouns and verbs, and no distinction, as in other languages, can consequently be founded on them. In the second division of languages there is, as above remarked, a much greater approach to the true inflexional character of the Indo-European languages; but, notwithstanding the really wonderful and highly poetical development of both Finnish and Hungarian, the peculiar and imperfect character of their original organization has never been fully overcome. No superfluity of forms, or delicate modes of expressing minute shades of difference of action, can ever counterbalance the want of this inner logical consequence, which can only be attained by an absolute separation of the grammatical categories. As examples of the existence of this kind of imperfection, even in Finnish and Hungarian, which are undoubtedly the most perfect languages of the family, we may mention that they have no true subjective and objective cases; the same word also often serves as noun or adjective. Finnish has a superlative degree, and both it and Hungarian a comparative; but they are wanting in all the other languages, and can only be expressed by particles and adverbs.

Character of second division.

We have not space to insist upon further grammatical imperfections, and shall therefore content ourselves with giving a few examples of the most characteristic resemblances which have been noted.

Assuming roots to be necessarily monosyllabic, we cannot help being struck with the general dissyllabic character of the simple words in the whole family. Even the foreign monosyllabic words, borrowed into Finnish for example, or the Chinese roots into Mongolian, are made dissyllabic by the addition of a rhythmical final vowel. Indeed the difference between the roots and simple words appears in all cases to consist in the clothing of the former with such a rhythmical vowel.

Rhythmical final vowel.

This dissyllabic character of the simple words is one of the circumstances which make Finnish, etc., tend so much to the trochaic rhythm. The root is inflexible throughout all the languages of the family, a peculiarity which distinguishes it in a marked manner from the Indo-European and Semitic families. It can neither have the vowel strengthened, interchanged, or subjected to metathesis; the only change of which it seems capable is the softening of a final consonant according to a certain law of harmony. There appear, however, to be some exceptions to this rule of root inflexibility in Lappish and Jurak-Samojede, and Böhtlingk has recently noticed the same circumstance in Jakutish. The root, on the other hand, influences all the suffixes.

Inflexibility of root.

In other languages accents appear to have a lengthening effect on vowels only; but in Finnish, Lappish, etc., the consonants are similarly affected, so that they help to protect the vowels from modification. This produces an equilibrium between the consonants and vowels, so that neither of them can be said to predominate. The heaping of consonants is thus avoided; for instance, in Finnish two consonants cannot begin or end a word. In pure Hungarian words also, two different consonants scarcely ever occur in the same syllable, and foreign words are often completely modified in accordance with this circumstance by the intercalation of a vowel between the consonants, thus—*Stephen;* Germ., *Stephan* becomes *István*, etc.[35] The same principle operates more or less in Mandchu, Mongolian, Turkish, and Samojede, especially as regards initial consonants, and, indeed, may be said to constitute a general characteristic of the entire family.

Action of accent upon consonants.

The most remarkable feature, however, of the northern family, is the peculiar law of vocal harmony which reigns throughout every member of the family. In these languages the vowels are divided into three classes: 1. hard (*majores*); 2. soft (*minores*); and 3. neutral (*mediæ*). To the first class belong *a*, *o*, *u*, to which in some languages *y* is also added; the second class contains the obscure or mixed vowels *ä*, *ö*, *ü*; *i*, and in some languages *e*, belong to the third class. Now the law of harmony is this: 1. If the root syllable of the word contains a hard

Laws of vocal harmony.

[35] Die Grundzüge der Finnischen Sprache mit Rücksicht auf den Ural-Altaischen Sprachstamm. Von H. Kellgren, Berlin, 1847.

vowel, *a*, *o*, *u*, (*y*), the following syllables cannot have a soft vowel, *ä*, *ö*, *ü*; 2. in like manner hard vowels cannot follow soft ones; 3. the vowel *i* is neutral, and may be followed by either a hard or soft vowel; 4. this is also the case with *e* in the Finnish and Samojede languages.[38]

The roots in the northern family form the first syllable of the word; or in other words there are no prefixes. This circumstance is in some degree opposed to the formation of compound words; but it is chiefly to the inflexibility of the root and the domination of the law of vocal harmony, that we must attribute the want of power in the languages of this family to form true compound words. They either use special words as a substitute for such compounds, or they seek to effect the object by different means. Thus in Finnish, instead of forming a true compound, one of the words is put in the genitive, as *puun latva*, the *tree's top*, instead of *tree-top*. One of the most characteristic distinctions between the northern languages and the Indo-European ones, is the circumstance that they have the same case suffixes in all numbers. The Northern Samojede dialects form an exception to this; they have different endings in different numbers, and in this respect approach therefore the Indo-European languages. The plural endings in several members of the family exhibit a great affinity. Thus in Finnish, Morduin, and Ostjak, it is *t*; in Mongolian it is also *t* or *ut* (*üt*); in Esthonian it is *d*; in Lappish, *h* (*k*); and Hungarian, *k*; in Tungus, *l*. In some others it is irregular: thus in Syrjænean, it is *jas*; Tcheremiss, *wylæ*; Turkish, *lar*. The affinity between genitive suffixes is still more striking, for as a general rule it is *n*; even the Mandchu ending *ni* or *i* can be scarcely considered an exception. No special affinity can be discovered between the other case-endings. In expressing the cases in plural, the root, in accordance with what we have said above, goes first, then the plural suffix, and lastly the case suffix; so that the plural suffix is intercalated between the latter and the root in converting the singular into the plural. A few examples will make this more intelligible, and at the same time show the character of the agglutinating principle. We shall select the Syrjænean word *mort*=*man*, the Osmanli word *Khatoun*=*lady*, and the Tungus word *bira*=*river*, so as to take our examples from

Dislike to prefixes.

Plural endings.

Case suffixes.

Agglutination illustrated by declension of nouns.

[38] Castrén—Grammatik der Samojedischen Sprachen. St. Petersburg, 1854, p. 23.

as widely different members of the family as possible. We need not, however, decline them fully, as that would occupy too much space, for there are no less than fifteen cases in Syrjænean, or rather sixteen, because there is a second ablative. We shall accordingly confine ourselves to two or three, and will separate for greater distictness the different suffixes by hyphens.

Syrjænean.

	Singular.	Plural.
Nominative,	mort,	mort-jas.
Genitive	mort,	mort-jas.
	mort-län,	mort-jas-län.
	mort-lys,	mort-jas-lya.
Accusative,	mort-äs,	mort-jas-äs.

Tungus.

	Singular.	Plural.
Nominative,	bira,	bira-l.
Genitive,	bira-ŋi,	bira-l-ŋi.
Dative-Locative,	bira-du,	bira-l-du.

Osmanli.

	Singular.	Plural.
Nominative,	Khatoun,	Khatoun-ler.
Genitive,	Khatoun-uñ,	Khatoun-ler-uñ.
Dative,	Khatoun-gha,	Khatoun-ler-gha.

Grammatical changes of verbs made by suffixes.

Nothing, however, shows the character of a language better than the verb. The grammatical relations, such as mood, tense, pronominal endings, etc., which in other languages are denoted by lengthening, interchange, etc., of the root vowel, by prepositions, or modifying particles, must be expressed in the northern languages by the successive addition of suffixes, which are subjected to the proper laws of euphony. The cause of this is the aversion of all the languages to prepositions, and the inflexibility of the root. In the most developed languages of the family,—the Finnish, Hungarian, and Turkish,—the verb possesses an extraordinary power of denoting modifications of action, and relations of the verb to the subject and predicate. The words formed in this fashion, though sometimes unwieldy, possess much poetical expression, and enable the freest scope to be given to the most exuberant fancy.

Order of attachment of suffixes.

In the conjugation of the verbs, the stock, or simple verb, formed by the clothing of the root, and which is most generally to be found in the second person singular, imperative mood, of the intransitive form of the verb, is placed first, as in the declension of the nouns. This is followed by the suffix, denoting the class of verb, as, diminutive, frequentative, inchoative, etc.; next comes the

suffix of form, that is, of active, passive, intransitive; after this, the suffix of mood; and finally, the personal suffixes. In Finnish, the personal endings are the same for all forms and modes, with the exception of the verb *ole* (be), and the manner of conjugating the same. Foreign influence has affected the Hungarian conjugation, and rendered it much more complicated. In Mongolian, properly so called, the verb does not take personal endings; but in Burjætish there is no verbal form without them, although they may be dropt; it is only the third person singular and plural, which, properly speaking, can be said to want endings, but they are more or less irregular. In Tungus also, the third person singular and plural are used without suffixes; the personal endings of the present and other tenses are a little different, but in the imperative, they are very irregular. It is probable that in all the Samojede dialects, the personal endings were formerly the same in all the classes, forms, etc., of the verb; but they have suffered modifications, and are not now alike. According to Castrén, the ending for the first person was *m*, which would agree with the Lappish, Syrjænean, Tcheremiss, Ostjak, Hungarian, Turkish, and also Finnish, in which it is *n (ni)*, but evidently by interchange with *m*. In Tungus, we also find *m* as an ending in the first person singular.

Personal endings.

It may be interesting to give one example of the manner in which the verbal suffixes are added in agglutinating languages. We shall select the Turkish verb *sev*, love; participle, *sev-er*, loving; infinitive, *sev-mek*, to love; present indicative, *sev-er-i-m*, I love (literally, "loving am I"). The present indicative is thus formed from the participle, *sev-er*, and *i-m*, the first person singular of the imperfect verb *i-mek (mek*, in the Turkish, is the suffix of the infinitive), to be; which is confined to the Ottoman dialect. This infinitive appears not to have been ever used;[37] *i-m* is formed from the root *i;* and the pronominal suffix *m*, in accordance with what we have mentioned above, that *m* was the suffix for the first person singular in the majority of the northern languages. The following gives the manner of forming the persons and numbers in the present indicative, and will serve to

Agglutination illustrated by conjugation of verbs.

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[37] Eclaircissements sur quelques Particularités des Langues Tatares et Finnoises, par F. L. O. Röhrig. Paris, 1845, p. 20.

show the principle upon which the other tenses are formed:—

Singular.			Plural.		
1st per.,	sev-er-i-m	= loving am I.	1st per.,	sev-er-i-z	= loving are we.
2nd „	sev-er-sen	= loving thou.	2nd „	sev-er-siz	= loving ye.
3rd „	sev-er	= loving.	3rd „	sev-er-ler	= loving.

In the second person singular, the suffix is *sen*, thou; the third person singular has no personal suffix, giving us an example, in a comparatively highly developed language, of what we have stated respecting Burjætish and Tungus. The first person singular is regular, the suffix being formed from the root *i* (from *imek*), and the soft *s*=*z* suffix of the first person plural; the second plural has *siz*=ye; and the third person plural has merely the simple nominal plural suffix. A still better example of the independence and want of adhesion of the suffixes of agglutinating languages, is afforded by the manner in which the different forms of the verb are produced by intercalated suffixes. Thus:—

Active,	Infinitive,	Simple,	Sev-mek, to love.
	„	Negative,	Sev-me-mek, not to love,
	„	Impossible,	Sev-èh-me-mek, not able to love.
Transitive,	„	Simple,	Sev-dur-mek, to make love.
	„	Negative,	Sev-dur-me-mek, not to make love.
	„	Impossible,	Sev-èh-dur-me-mek, not able te make love.
Passive,	„	Simple,	Sev-il-mek, to be loved.
	„	Negative,	Sev-il-me-mek, not to be loved.
	„	Impossible,	Sev-il-èh-me-mek, not able to be loved.
	„	Transitive of passive,	Sev-il-dur-mek, to make that some one be loved.
Reflective,	„	Simple,	Sev-in-mek, to love oneself, to please oneself.
	„	Negative,	Sev-in-me-mek, not to love oneself.
	„	Impossible,	Sev-in-èh-me-mek, not able to love oneself.
	„	Transitive of reflective,	Sev-in-dur-mek, to make oneself to love.
	„	Negative of preceding transitive,	Sev-in-dur-me-mek, not to makè oneself to love.
	„	Impossible of same transitive,	Sev-in-der-èh-me-mek, not able to make oneself to love.
Reciprocal,	„	Simple,	Sev-ich-mek, to love reciprocally.
	„	Negative,	Sev-ich-me-mek, not to love reciprocally.

Reciprocal, Infinitive,	Impossible,	Sev-ich-èh-me-mek,	not able to love reciprocally.
„	Passive of reciprocal,	Sev-ich-il-mek,	to be loved reciprocally.
„	Negative of preceding,	Sev-ich-il-me-mek,	not to be loved reciprocally.
„	Impossible of the same,	Sev-ich-èh-l-me-mek,	not able to be loved reciprocally.
„	Transitive of reciprocal,	Sev-ich-tur-mek,	to make oneself to love reciprocally.
„	Negative of the preceding,	Sev-ich-tur-me-mek,	not to make oneself to love reciprocally.
„	Impossible of the same,	Sev-ich-tur-èh-me-mek,	not to be able to make oneself to love reciprocally.[38]

Resemblance between agglutinating and incorporating languages.

A verb *quasi*-inflected after this fashion, may grow to an extraordinary length, especially if the personal endings be added. There is, undoubtedly, considerable similarity between this system of agglutination, and the incorporating method of the American languages, the difference being chiefly in the circumstance that in the latter, even nouns (the object) are intercalated in the body of the verbal form, as in the examples given at page 86.

Semitic family.

There now only remain three families of languages to be noticed—namely, the African, the Semitic, and the Indo-European. The first is, in all probability, but a subordinate division of the second, in the same way that we have considered the American and Malayan as allied to the Chinese. In this respect the investigations of Professor Fr. Newman on the Berber languages are of great importance. With regard to the Semitic languages themselves, they are second only to the Indo-European in the perfection of their grammatical organization. Gesenius, Ewald, Schwartze, Lepsius, Fürst, Delitzsch, and Rödiger, have all laboured to establish an identity between the roots of the Semitic and Indo-European families; and this appears now to be generally admitted. There is a singular anomaly, however, in the Semitic roots; they consist, in many cases, of three consonants, and are, therefore, unpro-

Triliteral roots in Semitic languages.

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[38] Eléments de la Grammaire Turke, par P. Amédée Jaubert. 2me. Edit., Paris, 1833.

nounceable without the addition of a vowel; but such an addition immediately develops not a simple stock word, but a grammatical form. For example, analysis yields, as the root of the verb to kill, *ktl*, which is quite ideal; if we add *a*, *o*, etc., we get *ktal*, *ktol*, etc.; but these are no longer roots, but grammatical forms of the verb. The change of letter, which, in the Indo-European languages, is the chief means of forming words, is, on the other hand, in the Semitic ones, one of the most frequent means of inflecting. We may have occasion subsequently to refer to this anomaly in the Semitic roots; but as we shall have otherwise very little to do with this family, we will not devote further space to it.

Grammatical structure of Indo-European languages well known.

As every one must be sufficiently conversant with the characteristic grammatical organization of the Indo-European family of languages, of which Greek and Latin form examples in the fully inflected states, and English in the stage after the throwing off of those inflections, we propose to take for granted that our readers are already possessed of the kind of information relative to this family that we have endeavoured to briefly give about the northern one.

Languages belonging to Indo-European family.

We have now ended our proposed sketch of the principles upon which investigations in comparative philology are founded; and we may, accordingly, proceed to enumerate the members of the two families we have selected as examples, which have been grouped together in accordance with the results of such investigations. This list will be of great use hereafter, and hence it is that we propose to devote so much space to it.

INDO-EUROPEAN.—This family is divided into six groups:—1. *The Indian*, which includes the Sanscrit,

Sanscrit.

the oldest form of which is to be found in the religious books of the Hindoos—the Vedas. The classic Sanscrit, or the language of the Brahminical epic poems, the Ramayana and Mahabharata, etc., is newer, and already differs from the Veda Sanscrit in sound, verbal and grammatical construction.

Pali.

From these sprung the *Pali*, the language of the Buddhistic books of Ceylon and of India beyond the Ganges, and which, according to Lassen, must have been formed in India Proper 500 years before Christ;

Prakrit.

the *Prakrit*, or vulgar language, which occurs in the dramas along with pure Sanscrit, and existed fully 300 or 400 years before Christ. These are now all extinct; but a great number of languages derived from

them (at least verbally, though not always grammatically) are still spoken in India. These are divided into five chief divisions, namely, Bengali, Hindi (the Mohammedan court dialect, mixed with Persian and Arabic words, is generally called Hindustânî), Rag'aputra (central India at Udajapur, etc.), Mahratta, and G'ât (in Sind, Peng'ab, etc.). These include about twenty-six different dialects, according to Lassen. The Gipsy language is also considered to be a barbarized Indian dialect.[39] Modern languages of India. Gipsy language.

The *Persian*, *Medo-Persian*, or *Arian group*,[40] which includes the old Persian, whose oldest records are the arrow-headed or Persepolitan inscriptions on stone from the time of Darius and Xerxes; the Zend, an old language, but younger than the last, and so called from the religious book of Zoroaster, the Zend Avęsta (the living word). Its home is supposed to be Eastern Persia or Bactria. The Pehlvi, or more properly Huzvāresh, as found in the inscriptions of the first Sāsānidæ about A.D. 229, and which is impregnated with Semitic elements even more than modern Persian; the Pazend or Parsi (being called the former when written with Zend characters, and the latter when written with the Arabic characters), which was spoken in the time of the later Sāsānidæ, in the sixth and seventh centuries, until the conquest of Persia by the Kalif Omar. The preceding languages are now extinct, but the modern Persian has grown out of them, but mixed with many Arabic words from the influence of Mohammedenism. The other living languages of the Medo-Persian group are those of the Affghans; of the Kurds of Kurdistan; the Beluchi, of Beloochistan; the Tâg'îks, of Buchara. To these a great number of philologists—among others may be mentioned Bopp—are now disposed to add the Irôn or Ossetic of the Caucasus, while Schleicher considers that the Armenian has most affinity with this family.[41] Old Persian. Zend. Pehlvi. Pazend. Affghan, etc. Irôn and Armenian.

Latino-Greek group, called by Schleicher the Pelasgic family, understanding by the term Pelasgic the fundamental language from which both the Latin and Greek have been derived, includes the dead languages, Greek Greek and Latin.

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39 See Pott. Die Zigeuner in Europa und Asien, 2 Bde, 1844–45.

40 *Ārja* Zend *Airja* is the name by which these people originally designated themselves. *Iran*, the name of Persia, is derived from this word; from hence is also derived the term Arian, sometimes applied to the whole Indo-European family.

41 Schleicher Die Sprachen Europas, s. 131.

Romantic languages. and Latin, and the modern languages, Italian, Wallachian, new Greek, Spanish, Portuguese, and French—many of these languages being mixed with a considerable element of other groups.

Litthuano-Sclavonian group. The Litthuanian branch bears the same relation to the Sclavonic that the Latin does to the Greek—that is, it appears older. To the former belong Litthuanian Proper, or Prussic Litthuanian (to distinguish it from the Samogitic or Polish Litthuanian, which is less pure), the oldest of all the living languages of the Indo-European family, for it still retains the seven cases of the Sanscrit and the dual; the Prussian, usually called Old Prussian, spoken on the Baltic coast east of the Vistula, in the neighbourhood of Memel, up to about the end of the seventeenth century, but now extinct; the Lett, the popular language of Kurland, or Courland, and the greater part of Liefland—a language which is to the Litthuanian what the Italian is to the Latin. The Sclavonian branch, which is divided into two groups, in accordance with a separation which apparently took place some centuries after the Christian era,[42] into Antens and Sclaves. The Antic or south-eastern group includes in the first place the old Sclavonic church language, into which SS. Cyril[43] and Methodius, the apostles of the Bulgarians and Moravians, translated the gospels, epistles, and psalms, and other religious books, in the second half of the ninth century;[44] the new Bulgarian, which is very

Litthuanian. Lett. Church Sclavonic.

[42] This division is probably founded upon a passage of Procopius, Bello Goth. 2. III. c. 14:—"Formerly the Sclaves and Antens had only one name: both were called Σπόροι, I believe for this reason, because they are scattered in their villages (σποράδην)". The real origin of the name being, according to Dobrowsky and Schafarik, the word *Srbi*, the name they gave themselves, and from which our word Servian is obtained, and the still more correct German name Serben.

[43] SS. Constantine and Methodius were two brothers, natives of Thessalonica, a half-Sclavonic city of Macedonia, who lived about the middle of the ninth century. Constantine, or Cyril, as he was also named, was called from his learning the "philosopher". He became a monk early in life, his brother Methodius being a priest, and afterwards archbishop. They first preached to the Sclavonized Bulgarians, and in 861 Methodius baptized Boris, the Bulgarian king. With the view of furthering the conversion of the Sclavonic people, Cyril (probably assisted by his brother) set to work in 855 to make a Sclavic alphabet, and between that year and 862 the translations mentioned above appear to have been made. This new Sclavonic literature thus took its rise in the Greek Sclavonic countries, then passed into the Bulgarian countries, and finally into Moravia, where the gospel was also preached by the two brothers.

[44] Schleicher (Die Formenlehre der Kirchenslavishen Sprache, s. 28)

much degenerated; the Russian (Great, Little, and White Russian); the Illyrian, that is—*a*, the Serbian dialect, with Cyrilian alphabet, called Illyrian when the Latin alphabet is used; *b*, the Slovenic, to which the Vendish or Crainerish, the Carinthian, and Styrian belong. **Russian.** **Serbian.**

The second group is the Slavinic or Western, and comprises—the Polish or Lechish, the Bohemian or Tchechish, the Sorbish or Serbish of Lusatia[45] **Polish, etc.**

Germanic group,—the oldest known type of which is the Gothic of Ulfilas' translation of the Bible, made in the second half of the fourth century. Leaving out the Gothic, this family may be divided into three branches: 1. *Scandinavian*, comprising Swedish, Danish, Norwegian, and Islandic, the fundamental language being the Old Icelandic of the Edda and other Saga. 2. The Low German or *Niederdeutsche* dialects, comprising the *Low German* or Plattdeutsche, the oldest form being the old Saxon poem, *Heliand*, in alliterative verse, made, it is said, in the ninth century. This dialect had its own literature until 1662, when the last edition of the Bible in it was published. The Dutch and Flemish (or Vlamische); the extinct old Frisian and Anglo-Saxon, the basis of the English. 3. The upper or High German dialects, comprising the dialects of Southern Germany and of Eastern Switzerland. The old fundamental languages were the Fränkish or old High German, between the seventh and eleventh centuries, and the Schwabian or middle High German, between the twelfth and fourteenth centuries. Since then the new or modern High German literary language has been formed, but not altogether out of the High German, but by the aid also of the Low German upon the basis of the dialect of Upper Saxony. The most characteristic distinction between the upper or High German and the Lower or Platt German dialects is the change of the mutes, *p*, *t*, *k* in the latter into *f* (*pf*), **Gothic.** **Scandinavian dialects.** **Low German dialects.** **High German dialects.** **Difference between low and high German.**

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thinks that the language of these translations was probably Old Bulgarian. But as the Bulgarians, properly so called, were not Sclaves, but belonged to the Uralian or Tchudic race, and came originally from the region called Great Bulgaria, between the Don and Volga, he must rather refer to the Sclaves who occupied the countries on the Danube before the arrival of the Bulgarians.

[45] Called Polabic, from *Po=on*, *Labe=Elbe*, that is, living on the Elbe, and includes, or did include, a number of races such as Verlets, and who occupied the districts between the Baltic, the Oder, and the Elbe, Lusatia, and the part of Saxony east of the Saale, and believed to have also occupied Holstein, Mecklenburg, Lauenburg, etc.

z, and *ch* in the former—a change which, in all probability, arises from the great Keltic element in the population of Upper Germany.

Irish, etc. *Keltic group*,—the living languages of which are divided into two branches: 1. *Gaelic*, comprising the Erse or Irish, the Scotch Gaelic, Manx. 2. Cambrian or Kymric, comprising the Welsh, the Armoric of Bretagne (another dialect, the Cornish, died out about sixty years ago). As we hope that the Keltic language and literature will receive a large share of attention in this publication, we need not enter further into the character of the ancient languages of the group here.

Skipetar. *Skipetar*.—In the part of modern Turkey in Europe, along the Adriatic coast, from opposite the Island of Corfu northwards, and to the westward of the Bulgarians, exists a people known as the Albanians, or as they are called by the Turks, Arnauts, a portion of whom speak a peculiar language—the Skipier or Skipetar. They are generally looked upon as the descendents of the ancient Illyrians, who formed one of an extensive family of allied nations, that in ancient times occupied the country lying along the east and north-east coast of the Adriatic and thence even into Asia Minor, and to which the Getae or Dacians, the Mœsians, the Macedonians, the Epirots in Europe, and the Lydians, Carians, Phrygians, etc., in Asia Minor are referred. This language has been unclassed, opinion leaning towards placing it in the Northern Family. According to Schleicher,[46] however, the Skipetar is Indo-European; its nearest affinities being with Greek, but much corrupted.

Languages belonging to northern family. NORTHERN.[47]—This family consists of five well defined groups of languages, which most, if not all, philologists now admit to be so intimately connected as to constitute a distinct family and to have had a common stock language.

I. The *Finnic*, *Ugrian*, *Tchudic*, or *Uralian* group consists of four branches, each of which in turn comprises a number of languages, and these again of dialects:—1. Languages of the *Baltic Finns*,[48] comprising the Es-

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[46] Die Sprachen Europa's, S. 138.

[47] This family has received a great number of names, according to the particular point of view under which it was studied, such as—the *Ural-Altaic*, *the Altaic*, *Finnish-Tatarian*, *Mongolian-Tatarian*, *North-Asiatic* or *Turanian*, etc.

‡ All the Baltic Finnish languages are very similar to one another:

thonian, of which there are two principal dialects, the *Rewal* dialect spoken in Esthonia and the Island of Oesel or Samez, and the *Dorpatic* in Liefland, the language of the Lieffs or aboriginal inhabitants of Liefland; the Finnish proper, the dialects of which are classed into two divisions—the *West* and *East Finnish.* The language of the Laplanders, of which there are a great number of dialects. **Esthonian and Finnish.**

2. *Languages of the Volga Finns.*—The Finnish nations who occupy the basin of the middle Volga in the governments of Kasan, Nishne-Novgorod, Simbirsk, and Pensa, comprise the Tchuvatch or Tchuvash, Tcheremiss and Morduins, each of whom speak a distinct language which has several dialects. The Tchuvatch or Sujasch, of which there are, at least, two dialects, is so beturked, that but few Finnish words remain. This is also the case with the Tcheremiss, but in a less degree In the neighbourhood of the Ural Mountains the fusion of Finnish and Turkish elements has produced a new language spoken by the Teptiars. There are two dialects of the Morduin separated by the Volga, and so different that the people of one side understand with difficulty those of the other. **Tcheremiss, etc.**

3. *Languages of the Permian Finns.*—The Permian Finns occupy the country about the Lower Kama, the regions of the Lower Dwina, and the mouth of the Mosen. The eastern boundary of this branch was formerly the Ural chain, but has been pushed westward by the Voguls and Ugrians. This branch comprises the languages of the Votiæks (Voti or Voten), or as they call themselves *Uhd-Murd,*[49] the Syrjænians, and Permians proper. These nations speak languages which

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the most developed is that spoken in Finland, or Finnish proper. This must have been cultivated at an early period, because they have native words for writing (*kirjoittaa*) and for book (*kirja*). This writing was Runic, and has now been replaced by a Roman alphabet. The difference between the East and West Finnish may be shown by a few examples, thus, the personal pronouns, *myö*, *työ*, *hyö*, etc., in East Finnish, become *me*, *te*, *he*, in West Finnish. In the East Finnish dialects there is a great tendency for double consonants before diphthongs and long vowels; for example, the words *issäite*, *tullee*, *sannoo*, *lewwee*, in East Finnish dialects, correspond to *isäiti*, *tulee*, *sanoo*, *lewee*, in West Finnish. The influence of Swedish, among other causes, is quite sensible upon the West Finnish dialects. The whole subject of dialects, and the causes which have led to their development, has never yet been scientifically studied in any language, and yet it is the key of philology.

[49] Uhd=hospitable host, Murd=man; in Syrjænian mort=man, and also=homo Syrjænus.—*Castren*, *Elementa Grammatices Syrjænæ.*

II. *The Jakutish-Turkish Group.*[53]—This group may be conveniently divided into four branches, as follow: 1. Uighur. The Eastern, including the *Uighur*, *Tchagatai*, *or Old Turkish*, on the Mongol frontier about Lake Lob; it is the first Turkish language which has had an alphabet. The Uighur race is under the Chinese dominion; dialects of

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last quarter of the eighth century their empire extended to the Dnieper and the Oka, as is proved by their fortifying the line of the Don against the Petchinakhi (πατζιναχιταί). In the beginning of the eleventh century the empire of the Chasars fell, and the race itself was more or less beturked by the stream of Turkish hordes already pouring in by this the immigration gate of Europe. It is right to state that Dr. Latham (*The Natural History of the Varieties of Man*, *p.* 87), appears to assume that the Chazars or Khazars were Turks. His chief authority is the passage of Theophanes—Τουρχοί ἀπὸ τῆς ἑώας, οὓς χαζάρας ὀνομάζουσι. He also endeavours to prove that the Khazars and the Akatirs, the latter being undoubtedly the Huns of Priscus, were the same people. The weight of evidence appears to us to be against Dr. Latham's opinion as to the Turkish origin of the Khazars; and, on the contrary, his supposition that the latter and the Akatirs were identical, appears to be almost certain. In this case the Huns were Finnic if we make the Chazars so. Now this is exactly the conclusion to which one is forced by an examination of all the facts of the case. The Bashkirs, and especially the Meshtsheraeks, a name which reminds one of Magyar, are probably the remnant of the Chazars, and are, no doubt, closely related with the Voguls, who have evidently, in common with the races just mentioned, been driven northwards by the Tatar invasion. It is certain that the travellers, Plano Carpini and Rubruquis, who visited the Great Khan of Mongolia (the former as Envoy of Pope Innocent IV.) in the years 1247 and 1253, call the land of the Bashkirs (Baschart, Pascatir), Great Hungary. Rubruquis also expressly says that the language of that country was the same as that of the Hungarians—See Bergeron—*Voyages faits principalement en Asia* —*La Haye*, 1735; and also *Recueil de Divers Voyages*, *Leide*.—*van der Aa*, 1729; and also in the former work the account of the Minorite Ruysbœck, who visited the Volga countries in 1253, in which he states that the language of the Hungarians and Bashkirs is the same; a statement in harmony with that of Rubruquis just given.

Connected with the origin of the Magyars and the empire of the Chazars, we may mention the city of Madshar or Madshary, noticed, according to Karamsin, in the Russian chronicles, in the year 1318, and the very curious and remarkable ruins of which Gärber, an artillery officer of Peter the Great, discovered about the year 1726-1727 upon the Kuma, a river which falls into the Caspian near the Caucasus, and directly south of Astrachan. As our space does not permit us to describe those ruins, we must refer the reader who is interested further in the subject, to the account of them given by K. E. von Baer, in the fourth vol. of "*Beiträge zur Kenntniss des Russischen Reiches*. Petersburg, 1841". As a singular circumstance to which we may hereafter have occasion to refer, we may state that Castrén discovered that there was a river called the *Madjar* in the Sajan mountains, a part of the little Altai chain, a region which, upon many grounds, has been assumed to be the original seat of the whole Finnic, and perhaps of the whole northern, family of nations.

[53] This name has been proposed by Otto Böhtlingk. Ueber die Sprache der Jakuten Einleitung S. XXIX.

the tribes of Uzbek Turks who are found at Khasgar, Kokan, Kodjend, Samarkand, Buchara, and a few as far west as Chiva; that of the Karakalpaks, south-west of the Aral Sea, between the Amu and Syr. 2. The *Western Turkish dialects* include those of the Tarekameh, Quisylbashi or Turkomans, from Balk to the Caspian, along the Persian frontiers (another portion of this race occupy the western side of the Caspian, along the Kur, almost to Tiflis). The Karatshai, Nogai, or Mankat, and Kumuk of the Caucasus, the Turks, erroneously called Tatars, of the west coast of the Sea of Azof and the Crimea, also belong to the Nogai. The language of the Osmanli or Ottoman Turks of Constantinople, the most polished and richest of the Turkish dialects, but now largely mixed with Arabic and Persian. 3. *Northern and North-western Languages.* This group includes Quirkis or Kirgis of Independent Tartary, who are divided into three hordes: 1. The great horde or Burut, from beyond the river Sara, Su, or Sari, to Lake Balkash, and south to Khasgar; 2. The middle horde occupies the region of the high table land north-east of the Aral Sea, between the Sari on the east, the sources of the Ishim on the north, and westward to Lake Ak-Sagul and the sources of the Tobol; 3. The little horde, who occupy the region about the Berdianka, the Ileck, and other tributaries which fall into the left side of the Jaik or Ural; the Jemba, which falls into the Caspian, and eastward to the Ulu-Irgis, which falls into the sea, or rather collection of shallow seas, the Ak-Sagul; the dialects spoken by the pure Turkish or bastard Turkish races belonging to Russia, and generally, but erroneously, termed Tatars, including the Baraba of the Barabinz Steppes, between the Obi and the Irtish; the allied dialects spoken by races formed of pure Turks, beturked Samojedes and Yenissei Ostjaks in South Siberia—the Tomsk Turks; the Kusmezk on the Upper Tom, Jarinar, Tubalar, Birgus, Teleuts, Karagass, Katschinsk, Koibals,[54] Sojots, and the Tobolsk Turks; Bashkirs, Meshtsheræks, and Teptiærs, between the Ural and the Jaik, in the government of Orenburg;—these three tribes are believed to be beturked Finns, and their languages to have a large Finnic

Uzbek. **Turkoman.** **Osmanli.** **Kirgis.** **Siberian Turkish dialects.**

[54] The Koibals, according to Castrén (Reiseberichte und Briefe aus den Jahren, 1845–1849), belong to the unclassed race of the Yenissei Ostjaks.

element in them; Tatars of Kasan. 4. Jakuts or Turks of the Lower Lena, or as they call themselves, Sacha; isolated tribes of the Jakuts are also to be found in the midst of the Jukagirs, one on the middle course of the Indagurka, from lat. 65° N. to 68°, and another about the mouth of that river, in the region of the *Tundra*, and beyond lat. 70° N.

Jakuts.

Turkish dialects not well known.

The study of Turkish dialects has made but little progress; until very lately only two dialects, the Osmanli and, to some extent, the Uighur, were generally known. In consequence of this, it has frequently been affirmed that so little difference existed between them, that the language of Constantinople could be understood at Jakuzk in Siberia;[55] but we now know, thanks to the travels of von Middendorff and the grammatical labours of Böhtlingk, that the Osmanli and Jakutish are not so very similar; we believe considerable differences, grammatical and verbal, will be found between the multitude of Turkish dialects whose existence has been ascertained, when we shall know more about them than we can learn from the imperfect and generally incorrect vocabularies which we possess at present.

Berizine's classification.

Raschid-ud-din's.

Berizine[56] divides the Turkish dialects into three great groups corresponding to those above indicated (he leaves the Jakutish out of consideration); these three groups include nineteen dialects, which are distributed thus: to the eastern, he refers six; the western, five; and the northern, eight. Von Hammer[57] divides the Turks into twenty-four races—a classification founded upon that of the Persian writer, Raschid-ud-din, who manifestly confounds Mongolians and Turks in a great many instances.[58] Both classifications, and indeed all that we have seen, are manifestly based upon the most arbitrary considerations, and consequently we have adopted a purely geographical one, which, although not indicating the relationship of the different dialects, is at least convenient.

III. *The Samojede Group.*—The Samojede races con-

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[55] Klaproth.—Asia Polyglotta—S. 216.

[56] Recherches sur les dialectes Musulmans par E. Berezine—Première Partie—Système des dialectes Turks. Casan, 1848.

[57] Geschichte d. Osman. Reiches, Bd. x., s. 681–688.

[58] This conclusion has been arrived at from reading F. v. Erdmann's "Vollständige Uebersicht der Aeltesten Tuerkischen, Tatarischen, und Mogholischen Vœlkerstæmme nach Raschid-ud-din's Vorgange". Kasan, 1841.

sist of three principal branches, each of which speaks a different branch language divided into a number of dialects:—1. the western or Jurak Samojede, which comprises five dialects; 2. the east or Tavgy Samojede (also called the Avam Samojede, from the name of one of the dialects), also comprising five dialects; 3. the south or Ostjak Samojede, with three dialects. Besides these three principal branches, there are two smaller ones, the Yennissei branch, spoken by a race who occupy the lower course of the Yennissei between the Jurak and Tavgy branches; and the Kammasinz, in the middle of Asia.[59]

Castrén's classification of Samojede languages.

IV. *Tatarian or Mongolian Group* consists of three great branches, a division which also appears applicable to the languages. They are—1. the Mongolians, properly so called, who inhabit the inner table of Asia, called Mongolia, at both sides of the immense desert of Gobi. The Northern Mongolians constitute a more or less homogeneous people, the Kalkas, but the Southern Mongolians are split into a multitude of tribes. 2. Burjæts, who inhabit the region about Lake Baikal, and belong mostly

Mongolian.

Burjætish.

[59] Formerly the Samojede race was divided geographically and linguistically into two divisions—1. The Northern Samojedes, on the Lower Yenissei and along the Arctic Ocean into north-east Europe; and 2. the Southern Samojedes, in the highlands within which the Yenissei rises. The latter consisted of part, at least, of the *Sojots* or *Uliang hai* of the Chinese and the *Uriang chai* of the Mongols. This is a collective name employed to denote all tribes living in the Sajan Mountains. Among the Samojede tribes of this region, whether properly included among the Sojots or not, may be mentioned the Mators, the Arins, the Assans, the Karagass, etc., who roved as nomades partly within the territory of China and partly within that of Russia. They now speak Turkish dialects, but with certain idioms and peculiarities of dialects of a Samojede character. In religion they are Russians; in customs, habits, and dress, Turks. The single exception is the small horde or Uluss (the Abálakow), of the Kammasinz, who live within the region of the steppes, about the two small tributaries of the Yenissei, the Kana, and Mana. This horde comprises the so-called "Forest Kammasinz" of the Russians, the remaining two hordes being, one of Turkish, and the other of Yennissei Ostjak origin. They call themselves Kagmáshe, or in the plural Kagmashesang, and still retain a remnant of the Samojede mother tongue, which is rapidly becoming extinct. The vocal harmony, so characteristic of the entire family, existed in a much more perfect form in this dialect than in the more northern ones, in which it has become more or less obscured. We owe to the excellent and indefatigable Castrén, who visited the locality, a vocabulary of this dialect. It is also to him we owe the classification of the races given in the text, and the discovery of the true affinities of the Samojede group with the Finns. See his "*Reiseberichte und Briefe aus den Jahren*, 1845-1849. St. Petersburg, 1856", and "*Grammatik der Samojedischen Sprachen.* St. Petersburg, 1854".

Kalmuk. to Russia; 3. Oelœts or Kalmuks, composed of four chief tribes: Dsungar, Choshot, Torgod, or Turgut, and Durbet, who occupy the great steppes of the western tablelands between the Kuen-lun and the Altai, the Chuchu Noor and Lake Dzaisang. The Russian Kalmuks, who crossed the river Ural or Jaik in 1630, 1636, and 1703, and settled in the region at both sides of the lower Volga, but chiefly between that river and the Don, southward of Astrakan, were principally Torgod Oelœts. The greater part of them returned to Mongolia in 1771, on the invitation of the Emperor of China. A few isolated tribes of Mongols, known as Eimaks, are found in Northern Persia.

Mandchu. V. *Tungus Group*, comprising chiefly the *Western*, under which we may include the dialect spoken in the neighbourhood of Turachansk, on the Yennissei; the Tchapojir, about the Middle Tunguska; the Orotong about the lower Tunguska; and the Mangaseisk. *The Southern*, to which the following belong: the dialect about Kirensk on the Lena; that about Bargusin on the shores of Lake Baikal; that of the horse Tungus of Nertchinsk; the dialect of the Tungus on the Angara, near Irkutsk. *The Eastern*, including the dialects of the Lamut and Ochotzk, east of the Aldan Mountains on the shores of the Sea of Ochozk. All the dialects mentioned are spoken by tribes under the dominion of Russia, who, according to Hagemeister, do not in the aggregate exceed 35,000 to 40,000 souls.[60]

The languages spoken by Tungus nations under the dominion of China, are, with one exception, scarcely known. That one is the Mandchu, the only Tungus tongue which has an alphabet, which it has borrowed from the Mongolian. The Mandchu race which, since 1644, rules China, does not extend further north than lat. 46° N., according to Kimai Kim, a native Corean Catholic missionary.[61] North of the Sunggari, and between it and the Amur, which join one another, is found the nation of the *Ukin*, and further to the north-east, at both sides of the Suchalian, which is formed by the junction of the Amur and Sunggari, exists another nation known by the Chinese name of *Tu-pi-laze*, or Fish-skin Tatars. Both these

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[60] Statistische Uebersicht Siberiens,—quoted in Castrén's "Grundzüge einer Tungusischen Sprachlehre, St Petersb., 1856".

[61] Revue de l'Orient, Mai, 1846, quoted in Berghaus's Physikalischer Hand—Atlas vii. Abth. S. 5.

people are believed to speak Tungus languages, but they are not known, nor are the dialects to the north-west along the Amur to the Russian frontiers near Nertchinsk.

Sporadic Languages considered to belong to the Northern Family.—Philologists, under the influence of the Finn hypothesis, have successively added to the northern family a number of isolated languages, or groups of languages, which we shall enumerate in their order, proceeding from west to east. The affinities by which these languages are connected with those above enumerated are often very slight and unsatisfactory, and accordingly it is here that we become sensible of the confusion which prevails in the classification of languages, and of the very defective principles upon which the relative values of affinities are estimated.

Euskaric.—This language, which is considered to be the remnant of the old Iberian, is spoken by the Basque or Escaldunac people in the Pyrenees, and is a kind of language island, left as a philological monument, showing the extent of denudation of the ancient races produced by the Indo-European floods. **Basque.**

The Caucasian Languages.—This group includes all the languages spoken in the Caucasus, which have not been already classed under the Indo-European family or as Turkish, and may be subdivided into four branches: 1. Iberian branch (Georgian, Colchian, Suanic); 2. Abshas and Tcherkes; 3. Lesgian; 4. Mizshegian. There is so much affinity between the Georgian and the Ossetic, that, if the latter be made Indo-European, so must the former; a conclusion to which, indeed, Bopp appears to have come, inasmuch as he is inclined to consider the whole Iberian branch as Indo-European. Opinion varies very much upon this point, some philologists adopting Bopp's view, while many make the branch just named northern. But if this be added to the northern, so should, in strict logic, the Ossetic or Irôn and several others, perhaps also the Armenian; an alternative which Dr. Latham, indeed, accepts. *The Tibetian.* This language, although it is radically related to the Chinese, is not altogether monosyllabic, and consequently is intermediate between the Chinese and Northern families, to the latter of whom Schott refers it. *The Drawida Languages* of the southern part of the Peninsula of India and the various Hill Tribes. The *Jenissei Ostjak* along the Yenissei, and the various colonies of this branch in Central Asia within the

Caucasian languages. **Tibetian.** **Indian.** **Jenissei-Ostjak.**

Chinese frontiers, most if not all of whom have now probably lost their mother tongue. The *Jukagir*, *Tchuvanz*, *Korjak Tshuktshen*, *Kamtshadale*, or languages of the races who occupy the north-east of Asia, eastward of the Lena. To these may also be added the languages of the *Aïnos or Kurile* chain of Islands, in which it has been found that the peculiar laws of construction of the northern family are observed.[62] The language of the Greenlanders was added by Rask himself, as we have already seen. Recent researches of Mr. E. Norriss have shown that the fundamental vocal harmony and other peculiarities of the languages of the Northern family also exist in the Japanese and in the languages of the Lieu Khieu Islands. It is probable that the languages of Corea partake of the same peculiarities, because it is a historical fact that the Coreans are the descendents of the Siän-pi, the Tungus nation which occupied the land of the Northern Hiong-nu or Chiungnu (Turks), and amalgamated with them when the Chinese Emperor of the Han dynasty defeated that people at the mountain Kinwei in the neighbourhood of the Upper Irtish.[63]

Languages of North-Eastern Asia.

Japanese.

We have now, as we hope, shown how the two hypotheses, which we have selected as examples, have been built upon the results of investigations conducted in accordance with the abstract principles of comparative grammar. Our next step is their verification, or, to speak more correctly, to show how this has been attempted to be done. In the sense in which that term would be used in astronomy or any of the exact sciences, there cannot be, if indeed there ever can be, an absolute verification of ethnological hypotheses. We should not, however, on this account, neglect to avail ourselves of such imperfect substitutes as are offered to us. A science may afford several methods of verification: the more complex the subject, the more numerous they are likely to be. Although philological ethnology is an eminently complex subject, yet, strictly speaking, historical evidence is the only means hitherto available for the purposes of verification. But does history tell us of an Indo-European migration? Some writers answer in the affirmative; and accordingly we propose to state in what way

Verification of hypotheses.

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[62] Berghaus. Physikalischer Hand-Atlas, vii. abth., S. 6.
[63] Klaproth—Asia Polyglotta. Paris, 1823. S. 288, also 211.

and how far it does so. At this stage we do not propose to venture to put forward any opinions of our own, and what we shall say, as well as what we have already said, must therefore be looked upon merely as a summary of the most advanced views of recent writers.

History does not inform us of the condition of the parent people from which it is assumed the Indo-European nations have sprung. But knowledge of this kind would be very useful, indeed is indispensable, to enable us to exercise a critical judgment upon the obscure events which constitute the only historical evidence which can be brought forward to support the presumed migrations of races. We must accordingly seek for this information in some other quarter, or rather in the only one to which we could look—an examination and comparison of all the words expressing family relations, government, cultivation, etc., now existing in the Indo-European languages. Condition of parent Indo-European race.

We have seen that, independent of the doubtful members, there are six great groups of languages of the Indo-European family: the western division, comprising the Keltic, Pelasgic, German, Sclavonian; 2. the eastern, comprising the Persian and Sanscrit languages. Now, the question naturally suggests itself, did these nations migrate from the common country at one and the same period, or were there separate successive emigrations at distant intervals of time? Some adopt the opinion, that there were several distinct emigrations, that of the Keltic family being the most ancient, and of the Indian the most recent. The unequal development of grammatical organization which the different members of the family exhibit, and other peculiarities, are considered by many to favour the latter view. The other opinion is, that the emigration was simultaneous, or that at least the European portion was part of the same great wave; the grammatical differences being accounted for by contact with, and incorporation of, foreign elements, as the wave of population progressed westward, the Keltic being assumed to have been modified by members of the northern family, and the Sclavonic by the Semitic, as we shall see by-and-by. Was there but one, or were there several Indo-European migrations?

The comparison of the different categories of words alluded to above, in all the Indo-European languages, has led to some extremely interesting conclusions. There is an almost complete agreement between them in the words expressive of the relationship of members of the same family. In most cases, too, their original meanings are Ideas of family among the parent race.

discoverable, and these give us glimpses of the character of the family idea in the oldest time. Thus for example: brother was considered as the protector as well as the father, sister as the foundress of a new family, daughter as the milker.[64] The form of government must have also advanced beyond the condition of the patriarchal family, because we find a Sanscrit word *viç pati*—Zend, *vîç paites* the master or lord of a place (*viç* being intermediate between a house and a city), exists in Litthuanian in the form *wiesspati*, a man of rank, a lord, and *wiesspatĕnĕ*, a woman of rank. *Patnî* signifies in Sanscrit a woman, and in Greek the second part of the word is πόσις instead of πότις, Latin *potis*, feminine ποτνία, mistress, and forms the second part of the word δεσπότης, a despot, feminine δέσποινα, which is a retrenched form of δεσποτνία, the original meaning of which was protector, as it comes from *pâ*. *Pâla* in Sanscrit has the same meaning; and the words for father in the European languages come from the same root. Thus from the same root two derivatives have been made, one of which expresses protector of the family, and the other protector of a number of families. The same root *pâ* is also found in the Sanscrit word *gôpâ* or *gôpa*, which originally and still means shepherd (cowherd), but at the same time also protector and defender in general, and in this sense was applied to the gods. It also signifies king, as *gôpalâ* and *gôsvâmin*—originally a possessor of cows. These words prove that the Arians were originally ruled by shepherd kings.

Form of government.

The most usual words for *king* in Sanscrit are *Ràg'* and *Ràg'an;*[65] they correspond to Latin *Rex;* Gothic, *Reiks;* Irish, Ríġ. The root of these two words is dittologous: in the first word it appears to have the force of *regere*, to judge; in the second it must mean to shine, but, at the same time, to rule; for the Sanscrit word for silver, *rag'ata*,—Gr., ἄργυρος; Lt., argentum; Irish, aırġeaᴅ, is derived from it. The king, therefore, appears in the high position of judge.

Mode of warfare.

The commonest mode of warfare of the parent Indo-Europeans appears to have been in chariots. *Ratha* is

[64] S. A. Kuhn—Zur Aeltesten Geschichte der Indo-Germanischen Völker. Osterprogramme des Real-Gymnasium zu Berlin aus dem Yahre, 1845, p. 3. Also, Lassen-Indische Alterthumskunde, Bonn, 1847, 1str Bd., S. 813.

[65] *Rig'u*, superlative *rag'isht'ha*, means direct, therefore, the straightest way; *rig'ûju*, loving the right. *Ante* note 64.

the Sanscrit for chariot, and in the Zendavesta the warriors are called *rathaêstâo*, that is, standers upon chariots. Their chief occupation was the herding of cattle, as is proved by the great number of words, especially in Sanscrit, which appear to have originated in pastoral habits. Great wealth was connected with the possession of cows; and the vedas are full of allusions to the ancient pastoral life. The words for cattle, and several of the domestic animals, such as goose, swine, boar, etc., are common to several members of the family. This pastoral life was not apparently the nomadic life of the Mongolians or Turks, but a fixed one, the land being cultivated to some slight extent. Agriculture could not, however, have been much practised. While the East Arians (Indians and Persians) have the same word for plough, the European members of the family have different. And J. Grimm[66] has shown that there is much more frequent identity between words connected with pastoral life, than between those relating to tillage. That they were acquainted with corn to some extent at least, is proved by the word *java*, Sanscrit for barley, existing in one at least of the European languages, though applied in a generic instead of a special sense—namely, the word *jawai* (plur.), which in Litthuanian signifies corn or grain generally. Perhaps part of the original race, who owned the rich valleys, tilled the lands, while those who occupied the plains were only shepherds. We have many examples of this kind in the present chanates of Chiva and Buchara, forming part of the supposed original home of the race. Connected with the question of a single or several successive emigrations, we may mention a circumstance which speaks in favour of the former view, or rather in that of the simultaneous wandering from the original seat of the race, and the subsequent splitting up of the migrating horde after it had come in contact with civilized Semitic people; namely, that many of the words connected with tillage are common to Greek, Latin, German, and Sclavonian. Agriculture must also have been early practised among the Indian Arians; for the word *Krisht'i*, which is derived from the verb *Krish*, to plough, was a common expression for men at an early period.[67]

Occupations.

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[66] Geschichte d. Deutsch. Sprache. S. 69.

[67] The following observations of Professor Wilson, on this subject are interesting:—

Weaving appears also to have been known to the parent race, as the word for it is common to several languages. They also had regular houses.[68] At an early period too there must have been considerable associations of people among the parent race, because in addition to the word *viç*, already mentioned, denoting a place, we find already in the vedas the word *grâma* for village, and the word *pur*, or in the later form, *purî*, for city. Now the word *viç* is probably the root of the Latin *vicus*, village, and of the great number of derivatives which have been formed from it; while the Greek πόλις = city, corresponds exactly with *purî*.

Associations of people.

Curious glimpses of the state of intellectual development among the people of the parent stock may also be obtained from a study of the words expressive of abstract ideas, religious or otherwise; but this is not the place to dwell further on the subject. Those who are interested in it will find a good deal of matter in Grimm's work above quoted. In the second part of this paper we hope to employ this kind of investigation in a new point of view.

Intellectual development.

The preceding observations upon the parent race will prepare us for discussing with more advantage its subsequent migrations. Of the emigration eastwards and southwards to Persia and India, we purpose to say nothing, referring those who wish to study that part of the subject to Lassen's great work on Indian Antiquities. The subject consequently narrows itself into the migrations of the Pelasgic, Sclavonian, Keltic, and German branches, which we shall treat of in the order named.

Migrations of parent race.

"At this period (epoch of the earliest of the Vedas) a pastoral people they might have been to some extent; but they were always, and perhaps in a still greater degree, an agricultural people, as is evidenced by their supplications for abundant rain, and for the fertility of the earth, and by the mention of agricultural products, particularly barley". . . . "They were a manufacturing people; for the art of weaving, the labours of the carpenter, and the fabrication of golden and of iron mail, are alluded to; and, what is more remarkable, they were a maritime and mercantile people". *Rig Veda Sanhita. Translated by H. H. Wilson*, p. 57.

[68] In Sanscrit *dama;* Gr., *δῶμα* Lat., *domus;* Rus. *domi.* According to Grimm, the Gothic word *timrjan*, to build, contains it, being related to Δέμειν (Ion. pro. οἰκοδομέιν) to build a house. A similar correspondence may be observed between the parts of a house; thus, for example, *door*—Sanscrit, *dvâr;* fem., *dvâra;* Old Persian, *dhuwara;* Kurd, *deri;* Armenian, *durhn;* Gothic, *daur;* Gothic of the Crimea, *thurn;* old high German and old Saxon, *dor;* Lett. *durwis* (*durris*); Litthuanian, *durrys;* Rus., *dver;* plural, *dveri;* Greek (plural), θύρα; Aeol., θυρα; Irish, doras perhaps the Irish tiġ, a house, is similarly related with the Gothic *timrjan.*

If we accept the Fin hypothesis, the countries into which the Indo-European immigrations took place must have been fully inhabited. In their route westward lay the fertile regions watered by the Tigris and Euphrates, and the rich Asiatic countries bordering the Mediterranean, and we may also add Egypt. Those beautiful regions, once teeming with abundance, now partially converted into deserts, or withering under Turkish rule, were the seats of great empires, of a high civilization, of rich and flourishing cities filled with magnificent palaces, even during the mythological period of Grecian history, and long before the dawn of its chronology. If such a movement of races took place, it must have been excited by the same causes, especially the love of plunder, which in historic times, between the fourth and seventh centuries of our era, brought those hordes of barbaric people into Europe who destroyed the ancient civilization of Greece and Rome. No doubt the conquests of the Babylonian and Egyptian princes carried the fame of their power, magnificence, and wealth, as did those of Rome at a later period, far into the heart of Asia.

The countries traversed were already peopled.

Plunder the inducing cause.

Although we have no accurate chronological histories of Babylon or Egypt in which we might hope to find a record of such a migration, yet so mighty an event could not have occurred without leaving traces of it in the monuments of those peoples, and especially in their monumental inscriptions. The supporters of the Indo-European hypothesis have accordingly sought for such traces in Nineveh and Egypt, and have ransacked every legend and myth of Greece, and have done much good service by their labours in the field of ancient history, if they have not gathered much fruit of the kind they sought. The more sanguine theorists have found abundant facts in favour of their hypothesis. Whether the proofs thus supposed to be obtained are such as would satisfy the requirements of strict logical inductions, we will not now attempt to determine. The illustrations which we propose to give of those speculations will, we hope, enable our readers to estimate their general character, and their value as historical evidence.

No accurate chronological history of such migrations.

Some writers think they can discover traces.

Perhaps the most positive speculations are those of Kruger,* because he is not satisfied with connecting

Kruger's speculation.

* Die Eroberung von Vorderasien, Egypten und Griechenland durch die Indo-Germanen. Von J. Kruger, Bonn 1855, as the first part of his "Urgeschichte des Indogermanischen Völkerstammes".

events, which stand, as it were, between the mythological and historical periods of ancient history, with the migration of the Indo-Europeans, but he even attempts to make a chronology.

Röth's opinion that the Pelasgi were the Hyksos.

One of the most remarkable speculations in ancient history is that of Röth,[70] about the Hyksos, an Asiatic shepherd people, who suddenly burst upon Egypt, then at the height of its glory under the twelfth dynasty of the ancient empire, devastated it, erected a new empire, and fixed its seat at Memphis. The new dynasty, which is known as that of the "Shepherd Kings", founded a great fortress in the Delta against the Assyrians, a kind of military camp, said to contain 240,000 soldiers, and is said to have ruled 511 years, when it was overthrown. According to Röth, the Hyksos, on the fall of their dynasty, appear as the Pelasgi, about whose origin so many hypotheses have been broached. This opinion of Röth's appears to receive corroboration from the discovery which has been made of Doric columns among the ruins of the temples of the ancient empire, while none could be found among those of the new empire which succeeded the Shepherd Kings.[71]

Now Herodotus appears to consider the Ionians as Pelasgi, and Böckh's researches lead him to the conclusion that the latter were not a foreign race, but an earlier phase of the Hellenic nationality. Rhode,[72] and perhaps others also, have pointed out an Arian or Indo-European element mixed with the Coptic. Röth has also given it as his opinion that the religion of the Hyksos was Arian or Indo-European, and Josephus states that the name of their fortress, Avaris, was derived from an old myth of the gods; but, according to Röth, the chief god which the Hyksos brought into Egypt was the Arian sun god *Hvare* (Horus).

Lepsius thinks the Aamu were Hyksos.

Lepsius, in his Egyptian travels,[73] speaks of the race of the Aamu, who wandered into Egypt under the twelfth dynasty, towards the end of the twenty-third century B.C., according to the chronology adopted by him, and whom he considers

[70] "Geschichte unserer Abendländischen Philosophie" as first vol. of "Die Egyptische und die Zoroastrische Glaubenslehre als die ältesten Quellen unserer speculativen Ideen. Von Prof. Eduard Röth, Manheim, 1847.

[71] Studien und skizzen aus den Ländern der alten Kultur. Von. Dr. Jul. Braun Manheim, 1854.

[72] Die Heilige Sage und das gesammte Religionsystem der Alten Baktrer, Meder, und Perser, oder des Zendvolks. Von J. G. Rhode, Frankfort, a. M. 1820, S. 5.

[73] Briefe aus Egypten. Berlin, 1852. S. 97.

as the predecessors of the Hyksos and to have been of their race. They are represented upon the Egyptian monuments with fair hair and blue eyes, characteristic of the Indo-Europeans. Bunsen and Lepsius have both rendered it probable that the horse was introduced into Egypt by the Hyksos. That animal appears nowhere on the monuments of the ancient empire, while it formed the chief power of the Egyptian chariot-warriors under the new dynasty. It is also certain that the oldest Semitic races did not know the use of the horse to the same extent; and, according to Herodotus, the Arabians in the army of Xerxes rode camels. Layard alludes to the fact that the Arabian horse, which has since become so celebrated, is not alluded to in the Bible, while it is often mentioned by the Assyrians; he further states that the Hebrew words *Sûs* and *Parasch*=horse, are derived from Susa and Persis, a signal proof, therefore, that it was foreign to the Hebrew people. As specimens of the kind of etymological arguments used in support of the Hyksos hypothesis, we may mention the attempt to explain Palestine to be Baal's land (*stan*=land). Pelusium, the subsequent name of Avaris, Pelasgi, Pelistim, are also believed to contain the word Bel or Baal. As the journey of the Israelites into Egypt took place under the dynasty of the Hyksos, the word Goschen is connected with the Sanscrit word *Goshana*=shepherd land. Again, there is every reason to believe that the Philistines were not Semitic, and Hitzig,[74] has even attempted to prove that they were Indo-Europeans. The other name, Carian, by which they were known, Kruger endeavours to connect with the word *car*=master, in Sanscrit and Zend; *hâr*, in old Norse; modern German, *herr;* that is, that they were the noblemen or lords in the land. Finally, the words which Bohlen[75] has adduced, in order to show the relation of Egyptian names with Sanscrit, may be added to the list; among these we may mention Ægyptus=*Agupta*, the hidden; Isis=*îsî*, the mistress; Amenthes, the Egyptian underworld=*Amanthas* in Sanscrit.

Horse introduced into Egypt by the Hyksos.

Specimens of etymological argument.

Upon these and similar data Kruger endeavours to prove that the East Arians or Indo-Europeans, under the name of Medes, advanced westward in the twenty-third century B.C., took Babylon, and established the empire of the

Indo-Europeans or Medes were the Aamu

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[74] Mythologie und Urgeschichte der Philistäer. Leipzig, 1845.

[75] Das Alte Indien, Bd. ii. S. 456.

and afterwards the Hyksos.

Medes; that about the same time their advanced posts penetrated into Egypt (2,200 B.C.), and were the fair-haired, blue-eyed people called *Aëmim* or *Aamu*, who appeared before the Pharao Sesurtesis II., and who must have been such an object of wonder to the black Egyptians, that they handed down to posterity the careful representations of them. Under the next king, Sesurtesis III., the first Sesostris of the Greeks, the glorious twelfth Egyptian dynasty reached the summit of its power. Obelisks, pyramids, noble palaces, tombs hewn in the solid rock, the world-famed labyrinth, the artificial lake Maeris, all attest the high cultivation, great wealth, and therefore extensive commerce and external-world relations of Egypt at this period. Sesostris appears to have fought successfully against the advancing Arians, for prisoners of this race appear often in the warlike scenes or tournaments represented upon the monuments, as the German prisoners of war were often the gladiators of the Romans. But to this splendour of Egypt followed suddenly a frightful downfall, at the same moment that an avenger of the oppressed Chaldean people arose in the north. In the year 2,100 B.C., Ninus, the Assyrian, destroyed the empire of the Medes, and scattered the Arian people; one portion went northward under the name of *Haik*,[76] another went south, destined to play a great part in the world's history. As Pelic Hyksos, they ruled the land and people of Egypt for centuries. But this conquest did not end their struggle with the Assyrians, for it lasted yet a long time. They sought to protect themselves against these world-conquerors by the great wall of Avaris; but the mighty Semiramis conquered them, and even, it is said, advanced as far as Ethiopia. Nevertheless, under her grandson, Arius, or Ariuch, a second campaign was necessary, which, however, only brought for some time the Palestine Hyksos under the Assyrian yoke.

For 260 years the dread of the Assyrians kept the

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[76] St. Martin, in his "Mémoires Historiques et Geographiques sur l'Arménie, Paris, 1841", tom. i., thus describes this advent of the supposed Arians into Armenia:—"The first general or prince who governed their land was a certain Haik. About 22 centuries before our era he left his native country Babylon and settled down with his entire family among the Armenian mountains, in order to escape from the tyrany of the Assyrian king, Belus. This prince, enraged at his secession, collected a numerous army and attacked Haik in the midst of his new settlement, but the fortune of arms decided against the Assyrians, and defeated in a great battle he lost his life."

Downfall of first Hyksos dynasty.

race of the Hyksos together, but as that diminished, the bonds of harmony weakened. The Hyksos, occupying the interior of the country, adopted the customs and religion of their more civilized subjects, and thereby exasperated their northern fellow-countrymen. At length, under Apophis, the last king of the first Shepherd Dynasty, it came to open civil war. His own family joining with the Egyptian people, he was dethroned, B.C. 1840, and, with his adherents, driven to the sea and expelled from Egypt. His son, Danaos, or Ion, laid the foundation of a mighty state in Argos, which ennobled the primitive inhabitants of the country, the forefathers of the Illyrians and Albanians. Another part of the adherents of Apophis, the Agenorides, conquered Syria, where they remained as Cadmonites until the fall of the second Hyksos dynasty in Egypt, 1589 B.C. About that time the Egyptians rose against their rulers and besieged Avaris with 480,000 men, and compelled them to leave Egypt, but allowing them to depart with their goods and families. They went to the number of 240,000 men to Palestine, driving northwards a wave of Semitic populations; the latter, in turn, driving the Hyksos, and especially the Cadmonites, settled on the coast, on the sea. Mixed with Semitic elements, these followed their brothers of the same race, and peopled Crete, Cillicia, Lycia, Rhodes, Tharos, Thracia, and Hellas. Cadmos especially appears to have been for middle Greece what Danaos was for southern.

Foundation of Argos by first Hyksos colony under Danaos.

Total overthrow of Egyptian Hyksos, and second migration to Greece under Cadmos.

Emim, Chorim, and Ennakim of the Bible, assumed to be Hyksos.

The greater part of the heroes of Avaris remained in Palestine, and as the nations Emim (perhaps more correctly Aêmim, and then connected with the Aêmim or Aamu, a few of whom wandered into Egypt, as already mentioned, under the Pharao Sesostris II.), Chorim, and Ennakim, of the Bible, lived in bitter strife with the Semitic people until their destruction by the Israelites, B.C. 1,300, in entering Canaan from Egypt. This exodus of the Israelites has been identified by Lepsius with that of Osarsiph, and therefore totally unconnected with the previous Hyksos emigration. The children of Enack are mentioned in the Bible as giants; the Hyksos were also considered so in Egypt; and what is singular, St. Martin[77] has a remarkable passage in which St. Ephrem, who lived in the middle of the fourth century, mentions the Kurds, Armenians, and their neighbours, as the descendents of

Armenians descendents of the Medes.

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[77] Mémoires Historique et Géographique sur l'Arménie, tom. ii. p. 255.

the giants; and Kruger even endeavours to connect the Armenian word Hesgaï=giant, with Hyksos and Haik.[78]

Solution of Mythos of Epaphos.

Kruger hopes that the question of, who were the Pelasgi? is now solved for ever. He accordingly believes there was no Argos before Danaos, and no Pelasgi, for with him came both name and people. He would seem, therefore, to refer the mythological genealogy given by Apollodorus and others, in connection with the mythos of Epaphos and Danaos, commencing with Inachos and ending with Danaos, Europa, Cadmos, and their children, to two periods, the one antecedent to the arrival of Danaos in Greece, and the other to that of Cadmos. In corroboration of this view he states that the latter name is found among the Phrygians and Armenians, and even in India.

Kruger's promised future researches.

Kruger promises to continue his researches on the history of the Indo-European family, and states that he is in possession of a Persian chronology which goes back to 2308 B.C., but giving positive dates for certain events as far back at least as 1118 B.C., and whose correctness is corroborated by its remarkable harmony with the Chinese, Egyptian, and Grecian chronologies. By means of this he believes he will be able not only to determine, in a general way, the period at which Zoroaster flourished—a point about which writers have differed, even to the extent of thousands of years—but also to assign positive

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[78] If the Irôn or Ossetii be really Indo-European, and that their name (Irôn) be derived from Iran or Persia, they should, upon Kruger's hypothesis, be part of the scattered Medes. Some form of the word *Haik* ought, therefore, to occur in their language. We have, however, failed in finding such a word in the "*Ossetische Sprachlehre*" of Sjögren (St. Petersburgh, 1844). No word for *giant* is at all given in the dictionary attached to that work.

The circumstance that one of the six races with blue eyes and fair hair, mentioned in the Chinese annals, was called *Hakas* (Klaproth, "*Peuples de Raçe blonde*", in his "*Tableau Historiques de l'Asie*", p. 161–186), adds considerably to the interest which Kruger's speculation has attached to the word *Haik*. These Hakas subsequently became the Kirgis; but Ritter (*Die Erdkunde von Asien, Bd. I., S.* 434), who considers the whole of these fair races to be Indo-Europeans, looks upon the Kirgis as a mixed race, composed of the remnant of the Hakas and Turks, to which must probably be added part of another fair race, the U-Sun (the Hieou-Siun of older, and the Ou-Si-un of later Chinese annals—*Abel Remusat—Remarq. s. l'extens. de la Chine Occid.* p. 96, quoted in Ritter, as above). In opposition to this, it may be urged that the Kirgis language is one of the purest Turkish dialects. But then, on the other hand, the Kirgis have more or less of a Mongolian type; and yet, scarcely any Mongolian words are found in their language. It would be of the greatest interest to examine the Kirgis dialects thoroughly for an Indo-European element.

dates for some of the principal events of his life. This chronology is to form the second part of the work already quoted, but which we have not yet seen.[79]

Dr. Donaldson's hypothesis of the Median origin of the Sclavonians.

The most recent hypothesis proposed respecting the line of migration of the Sclavonic members of the family, is that of Dr. Donaldson.[80] We shall merely state the hypothesis in general terms, and refer the reader for the arguments urged in its support, to the admirable memoir of the author. The basis of the hypothesis is the assumption that the Sarmatians (Σαυρομάται of Herodotus) and the Sclavonians were identical. Opinion is, however, divided upon this subject; Schafarik, perhaps the greatest authority upon Sclavonic philology, holding very strongly the view that they were distinct races.[81] Most scholars, on the other hand, agree in considering the Sarmatians as Medes. In a passage of Diodorus we are told that, during the Scythian possession of Asia Minor, Mesopotamia, etc., about the year 633–605 B.C., several of the conquered nations were transplanted to other regions, the most important of which were the Assyrians, who were located in the lands between Paphlagonia and Pontus, and the Medes to the region about the Tanais, and that these Medes were the subsequent Sarmatians. Pomponius Mela considers them to be nearly allied to the Parthians; Pliny and Ammianus Marcellinus also support the Median origin of the Sarmatians.

The chief tribes of the Sarmatians were the Jaxamatæ (Ιαξαμάται), the Roxalani (Ρωξολανοι), Iazyges (Ἰάζυγες), and the Alani. According to Gatterer's etymology, which is very generally received, the name Sauromatæ signifies the northern Mateni or Medes, while the name of the Jaxamatæ signifies Medes from the Jaxartes. If the original centre, from which the Indo-European parent race issued, be considered to be the Ak-tag and Mus-tag mountains, that is, that part of the western continuation of the Thian-Chan chain which crosses the Belur-tag chain almost at right angles, and the latter chain itself, corresponding in part to Kaffiristan, the country of the

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[79] It was to have been published under the title of "Wiederherstellung der Persischen Chronologie und Geschichte des Zweiten Assyrischen Weltreichs nach Persischen Quellen".

[80] On two unsolved problems in Indo-German Philology, by the Rev. J. W. Donaldson, D.D. Report of the British Association, vol. xx., p. 138 (Ipswich, 1851).

[81] Slawische Alterthümer, Bd. i., S. 333.

Siaposh, forming the watershed of the Oxus or Amou, and the Cabul, the race must have already extended itself westward, as far as the Tigris, at the period of the Median empire. Either then or later it is considered to have become subdivided into four branches: 1. the Arians, properly so called, who spread themselves over the Hindoo Koh, and thence over the mountains overlooking the Indus, whence they poured into Hindostan; 2. the Sacæ (Σάκαι), who occupied the Khorassan mountains and the country extending to Buchara and the valley of the Amou; 3. the Medes or Matians, who occupied the region about the South Caspian to the Assyrian frontier; and 4. the Persians, or as some call them, the Germanians. Now the question arises, were the Jaxamatæ or Medes of the Jaxartes the same as the Sacæ? The latter are evidently the Se, Sse, or Sai of the Chinese, and the Δάαι of Herodotus. They are usually classed among that undefined group of people, the Scythians, whom Schafarik concludes, though we think without reason, to be Tchudes or Ugrians. So that the Median origin of the Sclavonians has two difficulties standing in the way of its adoption; one, the identity of the Sarmatians and Sclavonians; and the other, the doubt as to who were the Sacæ of the Transoxiania or the region of Buchara and Khokand.

Assuming that these difficulties be removed, the Sclavonians are descendents of the Medes, and must have been in contact at a very early period with Semitic people; and, consequently, the Sclavonian dialects ought to exhibit traces of that contact. But the Semitic and Sclavonian languages stand in direct antithesis to one another, the distinctive characteristic of the Semitic languages being the general triliteral character of the uninflected words, to which we have already adverted, and the invariable syntactical contrivance by which the whole mechanism of speech is carried on. Dr. Donaldson attributes this result to the early adoption of alphabetic writing, the establishment of a literature, and the unusually frequent intermixture of cognate races. In the Sclavonic languages, on the other hand, the etymological forms are perfect, and there is a total absence of merely syntactical contrivances—circumstances that may be accounted for by the late period of the development of their literature, and that the Sclavonic people are the least mixed of any of the branches of the Indo-Europeans. If, then, Sclavonic languages

exhibit any traces of the contact with the Semitic, the argument would be the stronger from the unfavourable character of the circumstances under which the evidence would be obtained. Dr. Donaldson thinks, however, that there are verbal and phonetic coincidences between the Sclavonic and Semitic languages which cannot be accidental, and which are not traceable to any subsequent intercourse between the two races, and which are not found in the other European languages. He also points to the circumstance, that the distinction into perfect and imperfect verbs, which is so characteristic of Sclavonian dialects, as we have already mentioned, is common to all Semitic languages. Putting these and other circumstances together, and to which our space forbids us to refer, he concludes that the Sclavonians were Medes, and were, consequently, in contact with Semitic populations on the Assyrian frontier. Again, remembering the name Jaxamatæ, or Medes of the Jaxartes, the route by which they entered Europe must have been from the borders of Assyria, through Media and Hyrcania, round the eastern shores of the Caspian and Aral Seas, across the Tanais into Russia.

Kurds and Irôn also descendents of Medes.

As corollaries to this Median origin of the Sclavonians, we have two other hypotheses: one, that the Chaldeans, Kasdim, or Kurds, were also Medo-Persians. They are generally admitted to be an Indo-European tribe, who descended from their mountains and conquered the plains of Mesopotamia about the time of the prophet Isaiah. Some writers have claimed for them an alliance with the Sclavonians; and even those who deny this, as Ewald, look upon them as Medo-Persians. The second is, that the Irôn or Osseti of the Caucasus are descendents of the Alani, one of the Sarmatian tribes; and, consequently, upon the assumption that the whole Sarmatian race was Mede, the former must also be so, and specially related to the Sclavonians.

Conclusion from Hyksos and Sclavonian hypotheses.

Connecting the Sclavonian and Hyksos speculations, and assuming them to be established, the conclusion to which they would lead would be, that the Pelasgi, Sclavonians, Armenians, Kurds, and Osseti, were all Medes, and the downfall of the great empire of the Medes, the date of their separation. There is one important difficulty which suggests itself when the hypotheses are thus placed in juxtaposition, and which we cannot help mentioning: it is this: if the Pelasgi be Medes, why should not the

Greek and Latin exhibit as characteristic traces of contact with Semitic peoples as Dr. Donaldson assumes the Sclavonic dialects do? May not traces of so important a distinction as that between incomplete and complete verbs be found in early Greek, or still more probably, in the more ancient Latin, before the kind of literary action which is even now obliterating them in certain dialects of the Sclavonian, began to operate? Such an investigation, if it has not been already made, would possess great ethnological interest.

No consistent hypothesis for Keltic migration.

No consistent hypothesis has ever been proposed respecting the immigration of the Keltic tribes, for the simple reason that, although there have been more books written, and more theories broached about them, ethnologists, whether philological or physiological, have, generally speaking, possessed pretty much the same kind of knowledge about the Kelts and their language, as they have about the tribes and languages of Central Africa. The only definite hypothesis respecting their route into Europe, in accordance with the Indo-European hypothesis, is that suggested by K. Meyer.[82] According to him, the Kelts came from Asiatic Scythia, which would seem to imply that they originated from the tribe of the Indo-Europeans which we have called Sacæ, who occupied the region about Buchara. The immigration was not single, but consisted of several successive ones, divided into two distinct periodic streams flowing in different directions. The first was supposed to flow through Syria, Egypt, thence along the northern coast of Africa, to the Straits of Gibraltar, through Spain and into Gaul, where it split into three streams, one flowing into Italy, a second along the northern declivities of the Swiss and Tyrol Alps and the valley of the Danube to the Black Sea, and the third into Great Britain and Ireland. The second route of immigration was more direct; it entered by the depression north of the Caspian, across the Jaik and Volga, through Russia, and thence partly through Scandinavia, and partly through Prussia, and along the shores of the Baltic and the North Sea into England. Intimately connected with this hypothesis of the Keltic migrations is the very curious speculation of Meyer about the Irish Fenian tribe of Usnach, or as Meyer terms it, *Uasin*, whose

K. Meyer's speculation.

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[82] On the importance of the study of the Celtic languages. Report of the British Association for 1847, p. 30.

destruction is described in the beautiful poem of oiḋe ċloinne Uisneaċ (the death of the children of Usnach). This tribe he considers to be identical with the *U-sin*, one of the tribes of Central Asia, having fair hair and blue eyes, described, as already mentioned, in the Chinese Annals. We give this hypothesis without comment, but at a later period we propose to publish all that is known of this Oriental tribe, whenever the publication of a correct version of the Irish poem in the pages of this periodical may give us the opportunity.

The Germanic migration.

A recent writer affords us an opportunity of presenting, in its most matured form, the current opinions as to the line of immigration of the Germanic races.[53]

Ethnological survey of Europe before arrival of Germans.

After a few remarks in the usual spirit of the Neo-Germanic school, the principles of which have been so enthusiastically adopted in Scotland, about the Kelts, and also about their diffusion, he makes an ethnological survey of Europe at the commencement of European chronological history, which we shall endeavour to summarize in a few words. The extreme north-west of Europe, and the northern shores of the continental main land, were then occupied by the Gaelic Kelts in Ireland, North Britain, and Gaul; the Kymric and other Kelts, as the Welsh of England, and the Cimbri and Teutones (considering them as Kelts), lived on the shores of the North Sea, this being the position into which successive waves of people coming westward had driven them, as the first intruders into Europe. The Hellenic and Kelto-Italian successors of the Pelasgi occupied Greece and Italy, together with, in the latter, the intrusive Semitic Rasena or Etruscans. Spain and Portugal were peopled by the Iberi and Celtiberi, and some Phœnician or Punic colonies. Phœnician colonies also occupied the Mediterranean islands, and a small colony of Phocians had just founded Massalia in Southern Gaul. Inside this fringe of Mediterranean nations, the whole of Central Europe—from the Atlantic to the Adriatic, from the North Sea to the Alps—was occupied by Keltic races; the valley of the Danube, and thence eastward to the

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[53] Dr. Daniel Wilson, Professor of History and English Literature, University College, Toronto (Canada), and author of "Prehistoric Annals of Scotland", "On the Intrusion of the Germanic Races into Europe"—Edinburgh New Philosophical Journal, vol. i., new series (Jan., 1855), p. 33.

Euxine by the Scytho-Sarmatian stock.[84] These races being all assumed to be intrusive, must have previously displaced some other people, and either absorbed, extirpated, or drove them forwards, as in turn they, pressed upon by fresh swarms from Asia, moved westwards, till at length the Gael overflowed from Gaul into Britain, and northward into the Kimbric Chersonesus, and southward into Italy. These fresh swarms are assumed to be the Germanic stock, who entered by the only unguarded portal between the southern spur of the Ural Mountains and the Caspian Sea, probably about 500 or 400 B.C., and found their way along the banks of the tributaries of the Vistula to the Baltic.

Intrusion of Germans by the Immigration Gate of the Volga.

Different ways by which a migratory people may enter Europe.

Besides the maritime one of the Mediterranean, it is true there are only three routes by which a great migrating horde of people could easily pour into Europe. The first leading from the plateau of Iran and the highlands to the eastward through Hamadan (the ancient Ecbatana, the capital of the Medes), through the Elvend Pass, over Kermanshah to Bagdad—the route of Alexander the Great to India—then across the Tigris and Euphrates into Asia Minor, and across the Hellespont into Europe. The second route leading from the regions of the Oxus and Jaxartes, and the remarkable table-land, opening into the western depression of the Aral and Caspian Seas, which lies between the Altai and Thian Chan mountains, is along the littoral of the Caspian, at the foot of the Elbruz mountains, to the plains of Magan, at the mouth of the Araxes, thence by the low valleys between the Caucasus and the Caspian, and across the Don and Dnieper, and into the valley of the Danube. The third, also leading from the same central Asiatic regions across the Kirgis Steppes, the Jaik, and the peculiar depression lying between the low range of the Ural, called *Obtchei Syrt*, the Caspian, the Jaik, and the Volga, and across the latter into Russia, and then going northward to the Baltic, or south-westward to the Danube. Of these routes, Dr. Wilson selects the latter, which is that almost universally adopted by ethnologists, because the others were closed, Asia Minor being occupied by Lydians, Lycians, Phœnicians, and other warlike civilized races, while the Danubian countries were

[84] It would appear that our author assumes that not only were the Sarmatians the same as the Sclavonians, but that the Scythians and Sarmatians were also one and the same.

in the possession of Scythian tribes. From the Volga, he supposes them to have crossed Russia "along the northern edge of the impenetrable forests of Volhynia and Poland, and the water-shed of the Dnieper and the Vistula—the route pursued by the Huns under Attila in the fifth century—and thence along the tributaries of the Vistula to the Baltic", near Livonia and Esthonia. Thence they were compelled by their neighbours and predecessors from the East, whose power had been consolidated, and who had become settled, to cross into the "islands of Gottland, Oland, and to Scania, and there settling themselves in the great northern Scandinavian peninsula, where archæological research[85] proves

The route of the Germans from the Volga to Scandinavia.

[85] In the very next paragraph (p. 44), Dr. Wilson mentions the kind of archæological investigations which he considers confirmatory of the conclusion which he has advanced, relative to the late arrival of the Germanic Nomades in Western Europe. This is "the abrupt transition from the aboriginal stone relics, to the evidences of the metallurgic arts of the last pagan period, disclosed in the sepulchral depositories of Northern Scandinavia". The effect of prejudice in diminishing the power of critical judgment in man is really remarkable. The Neo-German School having decided in their own minds that all great discoveries, both abstract and practical, belong chiefly to the Germanic branch of the Indo-European race, of course the discovery of metals must have been made by them, and was, therefore, carried into their new settlement in Scandinavia! What if the German Nomades were ignorant of iron, and only learned its use in Scandinavia, or on their way thither! Yet such is, very probably, the case. The idea that three successive races occupied the north and north-west of Europe, the first of whom used only weapons of stone, the second bronze weapons, the third, being acquainted with iron, originated, I believe, in Denmark. In an excellent little guide to the ethnological archæology of North Europe, published by the Society of Northern Antiquarians of Copenhagen, having the title of "*Leitfaden zur Nordischen Alterthumskunde. Kopenhagen.* 1837", this hypothesis is stated, as it ought to be, with caution and reserve, and merely as a probability. Some of the members of that body have not imitated this good and scientific example; among others, Mr. Worsaae in his "*Dänemarks Vorzeit durch Alterthümer und Grabhügel beleuchtet. Kopenhagen*, 1844", looks upon the hypothesis as an expression of facts. Another and more recent writer of the same school is Mr. Axal. Em. Holmberg, who has published a popular exposition of the ancient condition of Scandinavia, under the title of "*Nordbon under Hednatiden. Populär Främställing af våra Förfäders äldsta Kultur*, 1854", in which the first part is devoted to—1. The Stone Age. 2. The Bronze Age. 3. The Iron Age, etc. Another work on the same subject, but which we have not seen, is *Fr. Klee. Steen-, Bronce-og, Jern-Culturens Minder, efterviste fra et almindelig culturhist. Standpunct i Nordens nuværende Folke-og Sprogeiendommeligheder.* 1854. That weapons composed of the three kinds of materials mentioned are found in tumuli, not only in Scandinavia, but also in Ireland and elsewhere in North Europe, is true; and this is just the whole amount of truth in the hypothesis—the three successive races, each in a distinct state of cultivation, being an interesting creation of imaginative archæology, which has found favour not only in the country of its birth, but in England, Scotland, and we may also add, Ireland.

them to have displaced an older Allophyllian population, they nursed their young strength, preparatory to their intrusion on the historic area of ancient Europe".

Incursion of Germans from Scandinavia into central Europe.

From the Scandinavian peninsula, he then supposes the Germanic race to have issued at a later period, and produced those grand disturbances which ended in the destruction of ancient civilization. Beginning by the displacement of the Kymri from Denmark, they seized upon the centre of Europe, from the Rhine to the Elbe, penetrating like a wedge between the Gauls and Sarmatians, causing a Keltic wave to flow over Central Italy on the one side, and into Britain on the other; and thus intruding the Gallic Cantii, Belgæ, etc., upon the older Keltic races. The pressure of the same Germanic wedge drove another part of the Kelts down the Danube, where they mingled or displaced the Illyrian and Thracian occupants already as early as the time of Alexander the Great. At a later period the Kelts invaded Macedonia and Ætolia under Brennus, and even attacked the Delphic Shrine; some also crossed into Asia Minor, where they peopled Galatia; the displacement of one race disturbing the eqilibrium of the whole chain of races throughout Europe and Asia, until the entire were set in motion, and finally poured as a vast torrent upon the Roman Empire.

Such, then, is the Indo-European hypothesis in the form in which it has assumed the greatest degree of consistency and development, by having attempted to add to the physiological and philological, the more definite and sure test of history. Taking this remarkable hypothesis as our basis, we hope in our next article to be able to investigate the problem we have in view—namely, how far have these migrations, if they are correctly stated, left recognizable traces in the languages and mythologies of the existing nations of Europe and Asia, as well as the general subject of the influence of physical circumstances upon the intellectual developments of mankind. We shall then also have an opportunity of making some observations upon the opposite theory of Latham, in which he denies the eastern origin (in the sense of the Indo-European hypothesis) of all the European nations.

W. K. Sullivan.

[*To be continued.*]

Art. III.—*Structural Characteristics of the Basilicas.*

THE buildings first used by modern society for the special purpose of what was a new worship, were the Basilicas. These buildings were no new invention, nor, on the other hand, were the Christians for the first time collected for worship within them. The basilicas existed under the Empire, and the new society had its meetings in small oratories or private houses, whenever the frequent outbreaks of persecution did not force its members under ground. Of the origin of the title Basilica there are several accounts, and the matter is of little importance except as indicating the use of the buildings so termed. Our modern Exchanges seem to come nearest to them, both in form and use, having both a large central space for walking and business, with covered walks or alleys by its side for the special resort of distinct traders or dealers. Besides this, the basilicas were halls of justice, and the recessed space at one end, termed tribune, was the court, with the seat of the judge raised against the centre of its wall, and benches for his assessors, and sufficient space in front for pleaders, and so forth. The side naves or walks were separated from the open centre by colonnades, which, in more splendid buildings, supported galleries appropriated to spectators, the sexes being separated. This is the outline of the basilica in its old state. It was roofed, at least in most instances, with the flat roof raised on coved sides, and thence termed *testudo*. There was nothing to compare to it among the existing buildings of antiquity for the uses required. Whether, however, these actually existing halls were permanently converted into cathedrals and churches is questionable. They were so used, doubtless, and formed the model for the ancient churches still preserved to us.

Origin of the Basilica. Its name and use.

There is a great deal to be said about the basilicas, not only in the way of very curious and interesting description, but on the principle they exemplify of adapting existing buildings, or existing models or notions of buildings, to purposes of worship, and of their other principle, of the taking no account of their exterior in comparison with their interiors.

Principles they embody.

They may be viewed, too, as the grandest examples of

Colour. decoration in colours that modern architecture has produced, and in many other respects.

It must suffice, for the present, to take a sketch of the various forms, developments, and modifications of these buildings, under their leading structural characteristics. Structure. Under this term basilica, we must include a class of buildings not always so named, which involved developments or additions that became the germs of great and wonderful features in the architecture of the greater periods, indeed of the greatest period, of modern art.

The basilica proper is an oblong building divided into three or more naves, the central being the most important, by colonnades, with a raised tribune, a sort of semicircular alcove, called the absis or apse (from the Greek ἀναβαίνω). This apse is separated from the naves by a wide transept running across the whole building, and generally extending beyond its limits of width, and spanning the central nave by a vast arch, called "triumphal". The apse exactly corresponds to this great arch, and sometimes chapels have grown in the back wall of the transept, corresponding, in like manner, to the arches opening into the side naves, so as to end the vista of all the colonnades with these recesses and altars. In the earliest churches, however, altars were less abundant than now, and the central apse was the only one existing. 1. The Basilica proper. Sometimes the side naves were double on each side (as in San Pietro), forming five with the central nave. Still the basilican oblong form remains in them all. The galleries, however, are not found in the earliest basilican churches. Coins remain which afford a rude representation of the great Ulpian basilica of Trajan, and from this one would gather that the galleries extended all along above the colonnades from end to end in that building. If so, the earlier churches built after these models omitted that feature, and raised the walls of their central nave on arches, or colonnades with flat architraves, under which access was given to the side naves. These naves, with the transept, apse, and raised tribune, under which was a subterranean chapel or "confession", in which the tombs of the saints were deposited, tombs which fixed the site of the church, formed the leading structural features of the basilica proper.

Besides this kind of structure, we have round and 2. Other forms. domed buildings, all variously taken after ancient models, particularly the Pantheon and the domed vaults of

the larger thermæ at Rome, which must be considered under the same general head. Though these circular buildings, with their developments of cruciform naves, involve great changes, and principles of construction far more subtle than any needed for the basilica proper, yet they belong to the age and grow out of the others, or are found parallel to them in an unbroken tradition.

The same spirit seems to have reigned over the architecture of these first eight or nine centuries of our era, and basilicas, whether Byzantine or Roman, were from a common origin—the monuments of the old Empire. In tracing this connection, we shall be led to consider all the varieties of structure belonging to this serious and imposing style of architecture, which indeed, taken as a whole, it may be doubted whether the grand system of the Lombards and Normans, or the romantic science of the Northern Gothic, surpassed in impressive effect, capacity, and convenience.

First growth.

The first growth made in basilican building, was, as already observed, the transept, which pushed back the apse. To one side, that of the entrance, was attached a square cortile, with open colonnades round, and sometimes a fountain in the centre. In the larger basilicas this seems to have been general, but few of them have survived the changes of so many centuries. This roomy court surrounded by dead walls, was familiar, from the accustomed arrangements of the Roman dwelling-houses of the more important class. It is still traceable in the mosque of Sta. Sophia of Justinian at Constantinople, the churches of San Vitale at Ravenna, San Clemente at Rome, Sant' Ambrogio at Milan, and other churches of the first nine centuries. It has disappeared from all the great basilicas at Rome, though we may take the double colonnades of modern St. Peter's as the representative of that of the ancient building.

Baptisteries.

The Romans attached distinct baptisteries to their churches. These generally followed the type of the existing circular buildings, from their obvious applicability. That of St. John Lateran, though altered, is still the same in main lines and parts that was built by Constantine, and in which he was said to have been baptized by Pope St. Sylvester. It is octagonal, and consists of an octagonal colonnade supporting a massive architrave, from which rises a second, supporting the octagonal roof. The lower

colonnade is surrounded by a wide passage or aisle for spectators. The centre descends by steps into the font.

Sta. Costanza, etc. The contemporary church of Sta. Costanza was built for a similar purpose, and was used for the baptism of the imperial family, who were buried in the great porphyry sarcophagus for merly placed in it, but at present in the Vatican gallery. The form of this church is still more elegant. It consists of a circular colonnade of arches on coupled columns, surmounted by a vaulted dome and surrounded by a vaulted aisle.

Their prototypes. On the same model were built the round church of Nocera and the circular church near Bonn on the Rhine. These were either directly on the plan, or mere modifications, of the circular aulæ of the baths, such as those of Diocletian, three of which still subsist. One forms the parish church of San Bernardo, and another, smaller, was incorporated by Vanvitelli into Michael Angelo's adapted church of Sta. Maria degli Angeli, that of the Carthusian Fathers. These are well constructed vaults of brick. The Pantheon, older than any of them, being so vast and massive that it was only the gigantic mind of Michael Angelo that has since conceived the idea of rearing such a mass into the heavens on piers and arches

San Stefano. Another circular church—that of San Stefano on the Cælian, said to be an ancient building—is larger than any of these, excepting the Pantheon, but less scientific. It is surrounded by an aisle, but the central part is traversed by walls on which an ordinary timber roof is supported. It was, however, too large and important to serve merely the purpose of a baptistery.

Galleries. Church architecture in Rome made little progress as to type and form beyond this point. Galleries, a marked feature in the basilicas of a more Byzantine character, are rare in Rome itself. Though a requisite in Constantinople for the use of women, they are not to be found in the early basilicas of Rome, or with few exceptions. That of St. Agnes is of the earliest age; but the fact of that church being built in the Catacombs, and, therefore, several feet below the surface of the ground, may have suggested it. The galleries surround the church on three sides, and are approached from the ground level. A very curious old church, called that of the Quattro Santi Incoronati, has also galleries on its two sides, ending abruptly at the altar end, so as to leave a regular basilican

transept between nave and apse; the galleries and their colonnades performing the part of the walls, which usually divide the great basilicas and support their roofs. This church is perhaps the most direct representative of the actual basilican hall of the old empire, as to its galleries, in existence.

By degrees, however, the rival capitals of Constantinople and Ravenna rose into importance as homes of art as well as seats of government. Their origin, as such, being Christian, they were, naturally, uninfluenced by the presence of a grand antiquity, with vast and various monuments of its power and activity. They received in the first instance a certain capital of ideas from Rome. In the case of Constantinople, its founder did all in his power to impart to it an artistic activity, and imported or constructed whatever he could to give it splendour and prestige. Here, as his mother, St. Helena, did in Palestine, he built basilicas, probably both on the Roman model, and that more interesting system to which the adoption of domed constructions in his capital naturally led. While ancient Rome adhered to, and has still retained its affection for, that element of length and simplicity of form which marks almost all its churches, the subtle Byzantines imbibed a deep attachment to the more scientific system of the dome, and the graceful circular colonnades and vaults which Constantine had made use of in the baptistery of Sta. Costanza. These arrangements present to the eye a certain variety and complexity of curves, and suggest to the mind a corresponding mystery, which the Orientals did not fail to dwell upon with inexhaustible delight, and to develop with a graceful, creative sense of beauty, which in its turn, and at several epochs, reacted upon the west.

Byzantine growths.

Proceeding first to Ravenna, we find, in the churches of St. Apollinare in Chiasse, the old station of the imperial fleet, and in some of the remains still existing of the episcopal palace, genuine remains of the times of St. Peter Chrysologus, magnificent monuments of the Roman basilica, with its mosaic decorations, and with the graceful development of a style of sculpture original and most characteristic. In Rome, where temples and thermæ lay in splendid and massive ruins on every side, the founders of churches had no need to quarry columns, nor to sculpture capitals or cornices. They had these ready to their hand. The consequence of this facility was, not

Ravenna. Its style of Sculpture.

only that the shafts were ancient, but that the capitals were taken indiscriminately, and where one or two shafts were of unequal length with the rest, the height was compensated by a block of three or six inches of capital. These are constantly varying, when taken from older buildings, and where they were sculptured for the occasion, the old forms were generally followed unchanged. In Ravenna, though both in this city and in Constantinople the emperors helped themselves to such precious shafts as were within a sea voyage, the architects originated capital and cornice mouldings for themselves. The general character of this sculpture, [illegible] rather than that of the empire in extremis, is interesting from its simplicity and originality. The acanthus-leaf capital is still used, but with a greater desire to appreciate its natural beauty, and with a certain delight in observing the fresh joyousness of living vegetation, blown by winds, and clinging round the convex mass, rather than gummed on to it in the old Corinthian manner. The convex form, as naturally indicative of the greatest sustaining power, is preferred to the old concave in capitals. This character of detail appears in the oldest of these Ravennese churches.

San Vitale. But Ravenna has some remarkable monuments of the age of Justinian and of Galla Placidia. The most important of these is San Vitale, an octagonal building rising into a dome and surrounded by a wide vaulted aisle, with a gallery above it, also vaulted. The arches on which this central dome rests are supported on massive piers, and rise to the height of the top of the upper galleries. Seven of these arches thus open into the gallery and aisle by a semicircular recessed colonnade, in two stories, falling into the arch above by means of a semidome and vault. The eighth side protrudes into a sanctuary that interrupts the circuit of the aisle and gallery, and ends in an apse beyond the octagonal outer wall. The roof of this portion of the church is a quadripartite vault of masonry, covered with mosaic. That of the apse is as usual.

Its portico. One feature common to all basilicas, that of the portico, appears in great beauty in churches of this description, and particularly in this of San Vitale. It is a wide enclosure, attached to one of the angles of the outer walls, enclosing, therefore, two narrow triangular spaces, which seem to form with the actual portico a double enclosure. There are openings into these spaces by

means of arches; but the walls are not cut away into regular colonnades between them and the aisle of the church.

Other domed octagonal churches at Ravenna are also of great interest. One of these, S. Giovanni in Fonte, is octagonal, and formed once the baptistery attached to the cathedral. A road now runs between the two. It has a raised font of marble in the centre, instead of the octagonal basin sunk in the baptistery of Constantine. This font, like that of the baptistery of Pisa, is large enough for immersion. The dome rests on the outer walls. S. Giovanni in Fonte.

One very remarkable feature in the dome constructions that were now building is the masonry of the dome itself. That of San Vitale consists of cylindrical pots screwed into each other, the tail of one made to fit into the mouth of the next. These are then carried round in a close spiral, like the structure of a straw beehive. Brittle as these earthen jars may seem, few constructions can be stronger, consistent with the lightness required, the cylindrical form of the jars, coupled with the extra strength of the doubled portions where the tails are inserted at regular intervals, being a full equivalent for the non-solidity of these voussoirs. Structure of domes with pots.

Another of the domed churches of Ravenna, somewhat later in date, must be noticed as a curious example of the very contradictory of such a system of construction. This is the church called Rotonda. It is circular, or rather polygonal with the effect of being circular. It consists of a very solid cruciform vault in the basement, into which the sea water has access. Above this rises the polygonal chamber, surrounded by a vaulted gallery, which was (for it is no longer existing) completely external to the main chamber, and only entered from it by two or three openings. The dome that covered the centre is of one single stone, hollowed out and cut externally into a bold convex, leaving massive stone handles, hollowed under, by means of which it was raised to its position. Against the outer surface of each of these stood, it is said, the image of one of the apostles. There is no trace of them now, the vault of the surrounding gallery having been destroyed. What is most curious about this enormous mass of stone, weighing 2,280,000 pounds in its rough state, and 940,000 pounds at present, is that it must have been the first stone of the building. It is quite In monolith.

inconceivable that, after the raising of the walls to the requisite height, such a mass could have been first raised and then moved by machinery wide enough to embrace the building and drop its roof upon it. The only reasonable explanation of it is that the stone was raised and held aloft by scaffolding till the walls rose and received it. As a *tour de force* it is a wonderful testimony to the energy and vigour of Theodoric the Goth, who had it made to support the porphyry sarcophagus he was buried in, which the traveller may now see attached to the front of his palace in one of the streets of Ravenna.

The Empress Galla Placidia has left us one of the most interesting of yet existing basilicas. It is very small, scarce forty feet in greatest length, cruciform, of the regular Latin proportions, and rises into a little dome at the intersection. The whole is vaulted in very massive masonry, and beautifully encrusted with marbles and mosaic. It was made to contain three heavy sarcophagi, for which there is just room in the three smaller arms of the cross. The central contains the remains of the empress herself; the others those of Honorius, her brother, and Constantius, her second husband. The body of the empress was preserved in full dress, sitting in a chair, down to the sixteenth century. It could be seen through an opening in the sarcophagus. Unfortunately, some children put into it a lighted candle, which caught the dress, and the whole was consumed. The opening is closed up, but how much of her imperial majesty may still remain unconsumed cannot be known. There remains, too, in this curious church a primitive altar. It stands under the cupola, is of the usual height and proportions, rather short, and stands on a single step or footpace. The whole is composed of slabs of white marble. That which forms the front is rudely sculptured with a cross, a lamb, and a dove, in low relief. On the altar is a small predella to hold the candlesticks: whether this forms part of the original may be doubtful, but the whole is a rare specimen of so small an altar in its ancient state.

Tomb of Galla Placidia.

Some of the imperial magnificence found its way into Rome in the form of the interesting basilica of San Lorenzo Fuori le Mure. It is the only basilica of the large class in Rome in which galleries are found. The present building has been much altered. The church of Galla Placidia, built in the fifth century, was to some extent rebuilt by Pelagius the Second, in 578; but the

San Lorenzo, Rome.

old columns either remained or were replaced and twelve fluted columns of pavonazzo enclose the sanctuary on two sides, and a third colonnade on the third. Above the side colonnades, which were half buried till they were opened twenty-five years ago to their bases, are galleries, with smaller columns of pavonazzo and serpentine. The burial of these lower columns seems to indicate that they and the galleries above them were of the original work of the empress, as it is not probable that freshly placed shafts should be buried in a new building. The restorations were of other parts of the church. The present nave was added in the eighth century by Adrian the First, who reversed the original arrangement, placing the opening of the nave where the apse had formerly stood. The raising of the ground in the present sanctuary has been occasioned by the height of the subterranean chapel containing the bodies of SS. Stephen and Laurence, and the level of both sanctuary and side aisles under the galleries was made to coincide with the top of this vault. If this was the work of Pope Pelagius, it accounts for the remarkable position of the columns in this older portion. It would otherwise obviously have been easier to cut the shafts than to go to the trouble of burying them to diminish their height.

The architecture of Galla Placidia and of Justinian made no more progress than this in Rome. In the east, however, the emperor achieved greater wonders even than in Ravenna. He determined to rebuild the church of Sta. Sophia, founded by Constantine, and found too small for the importance of the later city. Justinian had good reason for desiring to recal to the memory of his subjects his predecessor's object in its foundation. The present church, or mosque, is in plan a square enclosure of 269 feet by 243 diameter, of massive walls. This is subdivided into nine portions, the central being the great dome, from which radiate four arms of a cross, or four naves of equal length, and enclosing four square spaces in the four corners. The eastern and western arms of the cross are wider than the other two. They are formed by two semidomes of the same diameter as the dome, opening out from the base of the latter, and thus prolonging it into a vast oval hall. The northern and southern transepts are in stories, as are the four angular enclosures. The transept galleries and lower stories are subdivided by the two tiers of columns necessary to

Sta. Sophia, Constantinople.

support the vaulting and floor above. These four vast piers, on which the dome rests, with the eight corresponding piers in the outer walls, on which the various arches abut, which form the plan of the church, form so many admirably calculated points of support, and the connecting arches form them into eight enormous buttresses, sufficient to resist the lateral thrust of this bold cupola. It is the shallowest in existence for its enormous span of one hundred and fifteen feet; the depth being only equal to one sixth of this diameter. The height of the centre is no less than one hundred and eighty feet above the floor. It is lighted at its base by a circle of twenty-four arched windows. The interior presents to the eye the appearance of an oval vault descending on piers and arches, subdivided into arcades in two tiers. The eastern and western semicircles enter the angular enclosures of the square by semicircular recessed colonnades in two tiers, as in San Vitale, and the altar end protrudes into an elongated apse, which passes beyond the boundary walls, those on the east being made thick enough to enclose small chambers for various purposes, while the western subdivisions open by nine arches, three in each subdivision, into the vestibule, an inner gallery running the entire breadth of the building, and opening again by four arches into a broader portico, to which there are three doors, protected by three small external porches. Towers and staircases flank this double portico, and there are four square staircases, *en cordon*, for the ascent of mules or horses into the galleries. Justinian's predecessors had rebuilt the church once since its original foundation, and it had again been destroyed by the same means as in the first instance, viz., by fire. It was necessary, therefore, to construct the building of fireproof materials. The dome seems to be strengthened (according to Gibbon) by circles or chains of iron, the piers being of solid blocks of freestone. The weight of the cupola is diminished by its material, which is Rhodian brick of peculiar lightness. Unfortunately, the building was scarcely complete before a large portion of it was thrown down by the shock of an earthquake, a misfortune more common in that latitude than it has been since. The Emperor Justinian was not discouraged, but entirely restored it, strengthening the mass of the external piers, so that no settlement has taken place since. Like almost all the public buildings of the later empire, this was constructed in brick and crusted over with mar-

Its dome.

ble and mosaic. Confining ourselves, however, for the present to the structural character of these churches, we shall find that this type, once reached in Constantinople, began to spread in every province of the Greek empire, and to find its way further still, into India and Syria. In no long time the Mahommedan sect arose, grew, and propagated itself with fearful success and celerity. This dome construction was taken up by it, and Sta. Sophia became the type of the Arab architecture, destined some five centuries later to react upon that of the west, imparting much of its oriental elegance to the Norman and Frankish builders. Nine hundred years after the foundation of Sta. Sophia, the Turks were masters of that church, and followed it out in three or four magnificent mosques, those of Achmet and Suleiman being more scientific and graceful, though scarcely more solemn or impressive, than their original. With Sta. Sophia, however, San Vitale, San Nazzaro è Celso (the tomb of Galla Placidia), and the great churches of Rome, we must limit the class of buildings which are to be included under the head of basilicas.

Becomes a type of Oriental architecture.

Mosques, after its model.

Something more must be said about the state of decorative art during the period of their erection, and the mode in which it was applied to their ornamentation. The material of these buildings was in general brick; and for a kind of masonry, then only valued for its superior cheapness and utility, none ever was more accidentally sublime. That kind of work, of which traces still remain of the age of Honorius in Rome, called *reticulatum*, had gone out of use. It consisted in the facing of the mass being laid end ways, the bricks being square on the facing, and diminishing within so as to set in like teeth. The brick of Justinian's time, and commonly used in the basilicas, is the old, dark red, large, flat brick, a foot and a half long, with bands of large tile introduced, and arches turned in the same material. The quantity of mortar used, and the proportion of surfaces on which it fastens, form the secret of the extraordinary solidity of this mode of building. The walls and vaults become shells of solid rock. The campaniles, or bell towers, attached to the basilicas, usually distinct from them, are built round at Ravenna, elsewhere square, but without buttresses like our northern towers. The construction, then, of these churches being thus simple and solid, is usually left to speak for itself externally. As architec-

Decorative art of the Basilicas.

ture, the basilica builders had no sort of intention of challenging critics in their exteriors. They contemplated art in their interiors only. This was by a system of decorative incrustation. Very rarely had they the means, or did interest for the mode of building subsist a sufficient number of ages, to see this incrustation carried out to the exterior surface. The one great exception of St. Mark's at Venice, must be noticed separately. This mode of decoration was intended for the interiors. Mosaic of small dice or cubes of coloured marbles had been extensively used, chiefly for pavements, but also for roofs, by the old empire in later days. The incrustation of walls with larger and more magnificent veneers of marble was also common. The scale on which the imperial baths and palaces were built, necessitated the use of the more cheap and procurable material of brick; and the taste for importing rare and splendid marbles, could only satisfy itself by covering with them these vast protected interior surfaces. This system therefore became, in the hands of the rich and luxurious Romans, the most sumptuous source of architectural decoration. It was at the same time a system distinct from that of the structure itself. The latter was crusted over and concealed as by a coat, the forms and lines of which had no necessary connection with the mass beneath or behind it. These slabs of marble were usually made to cover the walls up to a given height, fifteen to twenty-five feet, after which occurs generally a string or cornice holding them and binding them into the wall, while it marks the division between the marbles and the mosaic decorations, which, being in small dice, could assume the character of pictorial representation. The sculpture on these buildings is usually executed in white marble, the shafts of columns being of various colours and monoliths. As already observed, there are two characters of sculpture in basilicas, the first being a simple imitation of the debased Roman work of the period, and usually executed to supply parts that were not to be obtained by ransacking the ruins of the city. The second period of sculpture, viz., all that executed in Ravenna, Constantinople, or elsewhere, where no older work was at hand, has a character of its own—sharp, severely controlled, but not wanting in vigour or grace. Constantinople and Ravenna furnish the most elegant and characteristic work of this kind. In this sculpture natural forms and the

Incrustation.

Sculpture.

appreciation of natural vegetation begin to reappear. For some ages the easterns seem to be ahead of the west in these respects; the east therefore will form the best field for study for details of these works.

The state of artistic design was undoubtedly at its lowest when these basilicas began to be erected as churches. Their historical designs are rude and conventional. The old Greek sense of beauty had died out in Rome. Luxury and vulgarity had gradually destroyed the manliness of the race, and such sense and love of beauty as it had possessed in days of vigour and prosperity. Constantine could find few competent artists either to sculpture his triumphal arch or to decorate his new capital. Still the Christian community had carried down with it into its subterranean oratories and chapels certain traditions of former times. Historical representations, even sometimes under mythological types, as that of Orpheus, are habitual to those interesting monuments. The classic tunic, and occasionally the nude figure, continued to be represented in their paintings. We shall find, as basilica building and decoration progressed, a marked difference between the simplicity of accessories of dress and ornament in the west, in contrast with the elaboration of colour and detail in the east. The basilicas of Justinian at Ravenna are interesting examples of this Byzantine spirit. They represent in more than one instance the emperor and his court, or his empress and hers, with details of costume carefully followed. But though these designs were rude, and showed ignorance of form, they were by no means wanting in grandeur. Quite the contrary. That nerve and vigour of character which luxury had eaten out of the Italian character, was beginning to grow anew from fresh sources, and Christianity really inaugurated the revival of the arts. That revival was slow, and conducted through most stormy ages of calamity, but a genuine revival it was. The peculiar changes of personal character which Christianity gradually spread, till it affected races and nations, often, probably to keen observers always, expresses itself in that index of the human soul, the face. Whether the early races of believers philosophized upon this fact or not, they were undoubtedly affected by it. It grew into an instinctive principle, that the face was the field, in man, for expressing character. The power of representing action or motive was therefore sought in the ex-

Decadence of ancient art.

Its revival under Christian influences.

Study of the human face in preference to the figure.

pression of the features, rather than the position or movement of the limbs. And though, of course, it was centuries before the refinements of art in representation of these objects could be attained, still some influence of the kind is observable in these early Christian representations, and, though rude, the faces and forms possess a grandeur which no art, with all its charm, has since surpassed; purpose, position, and architectural character of the representations being taken into account. Mosaics of glass, with gold ground or deep blue, worked in the same manner and material, were the means at the disposal of the architect for decorating all those portions of his church which either could not be covered with marble, or fell into the lines of curve or concavity caused by the arches of the roofs, domes, semidomes, and colonnades. We have alluded already to Venice. What marks so peculiarly the interest of San Marco, is its preservation of the basilican type after so many ages, with the additions of length from its western, and domes from its eastern associations. It is, besides, both decorated from pavement to keystone in its interior, and elaborately on its visible exterior portions besides. It exhibits the refinements of mosaic decorations both in historical subjects and their accessory details, and besides in decorations of borders, inlaid cornices, and the like. As to its form, we can only stop to give it generally. The church is small; its outline is a Latin cross covered by five domes; the eastern arm running into apse besides, and the western having the addition of the portico or vestibule running the entire width of nave and aisles. These aisles continue throughout the building. They are divided by arcades, which are not vaulted, but open at top, from the nave. They are covered above by the ponderous arches which support the sides of the domes, and are wide enough to bridge over the corresponding portions of aisle width lengthwise. The outer porch is vaulted, and rises to about half the height of the western façade; it opens by five arched doorways to the outer air. The front of this therefore forms the lower facade of the church, and the arches of the doorways rest on two tiers of columns of marble of all colours, the archivolts being of sculptured white marble. The columns are continued along the front with great effect, and, as in the basilicas, are monolithic. The pavement of San Marco is an admirable example of almost every kind of

San Marco, Venice.

marble mosaic, from the Roman and Alexandrian work down to the medieval Italian pietra dura. The Venetians had peculiar facilities for such modes of building, and were much under Greek influence while holding the key of the central waters of Europe. A detailed account of St. Mark's would require more space than we can now afford. But though so much later than the early basilicas, it is a wonderful exponent of their principles.

It remains, before concluding, that some comparative notice should be taken of the scale of the old basilicas, with reference to the larger churches of subsequent times. Comparison of scale with subsequent buildings.

	Length.	Total width.	Length of transept.	Height.
	Feet.	Feet.	Feet.	Feet.
San Paolo, in Rome, is in extreme length,	'419	214	279	120
Sta. Sophia, the largest of the Byzantine churches,	269	243		180
WITH THESE COMPARE				
The modern St. Peter's, Rome,	669	395	442 Cupola, 139	432 (Cupola and lantern). Church, 146
Sta. Maria dei Fiori, Florence,	454		334 Cupola, 133	Cupola, 387 Nave, 153
Cathedral of Cologne,	500	280	290	200 Towers, 500
„ Amiens,	444	84	194	141
„ Old St. Paul's, London,	500	91	248	102 Spire, 534
„ Winchester,	545	86	186	178
Duomo of Milan,	490	197	295	Spire, 400

It will be seen, indeed, from these few instances, how

greatly the elements of length and height increased in after times. That of cubic capacity, on the contrary, seems to have diminished. If we deduct from the medieval churches the parts walled off by solid stone screens or wooden partitions, and the immense space taken up by the piers necessary for the support of vaulted roofing, we shall see how decidedly the older buildings have the advantage, as far as the question goes of holding vast multitudes at a time. A simpler arrangement than that of the western basilica can hardly be conceived, and, graceful and wonderful as the subsequent architecture became in southern as well as northern Europe, no buildings whatever have surpassed these early churches either in solemnity or practical convenience.

JOHN H. POLLEN.

SCIENTIFIC RESEARCHES.

Art. I.—*On the Influence of the Great Inequalities of Jupiter, Saturn, etc., upon the Motions of the other Heavenly Bodies.* *By* Rev. W. G. Penny.

The product of the disturbing forces of two planets causes inequalities of long period.

IN calculating the amount of the perturbation in the path of one planet caused by the action of another, it is usual to assume that both the planets would, except for the inequalities caused by their mutual attraction, move accurately in ellipses, no account being taken of the small inequalities in the path of either of them caused by a third planet. But since in reality any alteration in the place of either of them causes an alteration in their mutual distance, it is evident, according to the theory of gravity, that their mutual attraction will be altered also; that is, that their disturbing force will be different; or in other words, that a new disturbing force will be added, which will produce its corresponding inequality in the path of each of them.

Now, the undisturbed place of a planet so nearly coincides with its actual place, that we may in most cases altogether neglect any difference in the disturbing force which arises from the planet not being exactly in the place where it would be if undisturbed; but we cannot do so always. For example, in the case of Saturn, there exists an inequality in longitude which is represented by $652'' \sin (2n_4t - 4n_5t + \Pi)$, together with another of about half the magnitude of the radius vector. These, in linear measure at least, are about equal to the eccentricity of the Earth's orbit; and therefore, under certain circumstances, are quite large enough to produce a sensible inequality in the motion of a neighbouring planet.

In fact, when we remember that the effect of a disturbing force depends not only upon its intensity, but also, in some cases, upon the square of the time during which it acts in one direction, it is evident that a very minute force, if its period is very long, may produce very sensible results.

In order therefore to complete the theory of planetary

perturbations, it becomes quite necessary to search out all forces of this kind whose period is very long, or in other words, to examine whether in the formation of the differential equations of motion, we may not by the employment of the *true coördinates* of the planets, find terms in the disturbing function which we should not find by merely using the elliptic ones, having a very small divisor, and which consequently will be much increased by integration. For example, suppose that we are calculating the mutual perturbations of Saturn and Uranus. Now, if we employ the terms above mentioned, which occur in the true coördinates of Saturn, it is evident that we shall obtain a term in the differential equations of motion of the form

$$B \sin(3n_6 t - 6n_5 t + 2n_4 t + \Pi)$$

n_4, n_5, n_6, being the mean motions of Jupiter, Saturn, and Uranus. This expression, as it will have to be twice integrated, will be twice divided by $3n_6 - 6n_5 + 2n_4$, which is a small quantity; and the term which results in the longitude of Uranus from the employment of the above mentioned and other inequalities which will produce terms of the same form, amounts to about 43 seconds. This, though much smaller than some of the inequalities in the path of Uranus, is still considerable with respect to many that occur in the planetary theory, being in fact larger than any that have been hitherto noticed in the motions of Mercury, Venus, the Earth, or Mars; and being more than five times as large as any of the perturbations of the Earth. Its period is about 1,700 years; and there will be corresponding terms in the longitude both of Saturn and Jupiter; that of Saturn amounts to about 40″, and that of Jupiter to about 10″.

Inequality of long period in

Another remarkable inequality of the kind which I have found, is one which appears to exist in the motions of the Earth and Mars.[1] Its period is somewhat longer

[1] Since the above has been in type, we have found that this inequality, as far at least as the motion of the Earth is concerned, has been already calculated by MM. Leverrier and Hansen. The coëfficient given by the former (see vol. xxx., p. 463, *Comptes rendus*) is 7.162″. That by the latter is 6.221″. That here obtained is 7.293″, which therefore agrees very closely with that given by M. Leverrier. Also the small inequality noticed further on, which depends on the disturbing forces of Mars and Venus, has been given by the latter writer; but not that depending upon the product of the forces of Jupiter and Saturn.

than the one mentioned above, being about 1,800 years, or about twice that of the long inequality of Jupiter and Saturn. It arises in the following way: Four times the mean motion of the Earth is *very* nearly equal to eight times that of Mars minus three times that of Jupiter; it has an exceedingly small divisor; and in fact the term which represents it in the disturbing function is multiplied by a quantity which amounts to upwards of twenty millions! This inequality appears to amount, in the case of the Earth, to about 7.29″, and in that of Mars to about 45″; quantities which are larger, and in the case of Mars very considerably so, than any which arise from simple perturbation; the largest hitherto known in the motion of the Earth, amounting to not more than 7.15″, and in the motion of Mars to 24.53″. the motions of Mars and the Earth.

One remarkable thing about this inequality is the effect which it appears likely to have upon the motion of the Moon. According to the investigations of Professor Hansen, the inequality lately discovered by Mr. Airy in the motion of the Earth, which amounts to about 2.05″ with a period of 240 years, gives rise to an inequality in the motion of the Moon amounting to about 23″; and therefore it would seem that there will also be a corresponding one arising from that above mentioned, and which will amount to something considerable. I have not been able to get access to Professor Hansen's investigations, and have not yet finished the calculation of the lunar inequality, and therefore cannot as yet give its precise amount; but I hope to have done so in time to publish the results in the second number of this Periodical.

And, in general, in order to find quantities of this kind, we must not only seek out all terms in which $p_1 n_1 - p_2 n_2$ is small, $n_1, n_2, \ldots$, being the mean motions of the planets, and $p_1, p_2, \ldots$, any whole numbers, but also all those in which $p_1 n_1 - p_2 n_2 \pm p_3 n_3$ is small with respect to any of the three quantities n_1, n_2, n_3, for all such terms will be much increased by integration. It will be seen that all such quantities will be of the order of the second power, or rather of the product of two powers of the disturbing force. It should also be observed, that in general, if $p_2\, n_2$ relate to that one of the three planets which lies between the other two, the quantity p_2 ought to have a different sign from p_1 and p_3, in the same way that where two planets only are concerned, p_1 and p_2 should have different signs; otherwise such high powers of the eccen-

tricities will be involved as will make the terms quite insensible.

The two combinations above given, namely $4n_2-8n_3+3n_4$ and $2n_4-6n_5+3n_6$, appear to be much the most remarkable; but there are others also which give rise to quantities which come within the limit at which it is usually considered necessary that they should be retained in the planetary tables; there are even one or two such involving the product of *three* disturbing forces, and consequently the coördinates of four planets One of them appears to amount to about 7″.

With regard to this limit of the quantities which are to be considered as worth retaining, it may be remarked that M. Bouvard retains quantities which exceed a centesimal second; and MM. Pontécoulant and Laplace go still further; the former retains quantities of one-tenth of a sexagesimal, and the latter of a tenth of a centesimal second. But with respect to the terms at present under consideration, it may be quite sufficient to retain only those which exceed a sexagesimal second, except, perhaps, in the case of the Earth; where it may be advisable to include smaller ones, in consequence of the inequalities which they may be the cause of in the motion of the Moon.

Equations of motion. To proceed then with the calculations: and first let us determine the inequality of the Earth and Mars.

$$\text{Let } R=\frac{m'r\cos(\theta-\theta')}{r'^2}-\frac{m'}{\sqrt{(r^2-2rr'\cos(\theta-\theta')+r'^2)}}$$

Where r, θ, etc., refer to the disturbed, and the quantities with the accents to the disturbing planet.

I employ the equations,

$$\delta\theta=\frac{1}{a^2n\sqrt{(1-e^2)}}\left\{d_t(2r\delta r)-\delta r d_t r+3\int_t\int_t d_t(R)\right.$$
$$\left.+2\int_t r\dot{d}_r R\right\}$$

for determining the alteration in longitude, and

$$d_t^2 r\delta r+n^2r\delta r=-2\int_t d_t(R)-rd_rR$$
$$-n^2r\delta r\left\{3e\cos\overline{nt+\epsilon-\varpi}+,\text{ etc.}\right\}$$

for determining that of the radius vector.

In the formation of these equations, several quantities depending upon powers of the disturbing force higher than the first, are omitted; but none of these quantities omitted appear to have any effect upon the investigations which follow; so that we may use the above equations as they stand.

Then, to find an equality in longitude of the form

$$P \sin (8n_2t-4n_3t-3n_4t+\Pi)$$

we must find all terms in R having the same argument. For this purpose we must expand R, and its expansion is effected in exactly the same way as in ordinary cases where we are considering the mutual perturbations of two planets only; that is, by making it depend upon the expansion of the quantity **Expansion of R.**

$$\frac{m'}{\sqrt{(a^2-2aa'\cos(\theta-\theta')+a'^2)}},$$

a and a' being the constant parts of r and r'.

This is done by assuming the quantity

$$\frac{m'}{\sqrt{(a^2-2aa'\cos(\theta-\theta')+a'^2)}}=\tfrac{1}{2}A_0+A_1\cos(\theta-\theta')+\text{etc.}\ldots$$
$$+A_k\cos k(\theta-\theta')+\text{etc.}\ldots$$

Then if we call $\dfrac{m'}{\sqrt{(a^2-2aa'\cos(\theta-\theta')+a'^2)}}$ A; it is evident that if we neglect for a moment the quantity $\frac{m'r}{r'^2}\cos(\theta-\theta')$, R is what A becomes when r, r', are written for a and a', or when we write $a(1+v)$ for a, and $a'(1+v')$ for a', where av and $a'v'$ represent the variable parts of r and r'; therefore we shall have by Taylor's theorem

$$R=A+avd_aA+a'v'd_{a'}A+\text{etc.}$$

Now since

$$A=\tfrac{1}{2}A_0+\ldots\ldots\ldots+A_k\cos k(\theta-\theta')$$

we shall have

$$ad_aA=\tfrac{1}{2}ad_aA_0+ad_aA_1\cos(\theta-\theta')+\ldots\ldots\ldots\ldots$$
$$+ad_aA_k\cos k(\theta-\theta')+\ldots\ldots\ldots$$

$$a'd_a\mathrm{A}=\tfrac{1}{2}a'd_a\mathrm{A}_0+a'd_a\mathrm{A}_1\cos(\theta-\theta')+\ldots\ldots\ldots$$
$$+a'd_a\mathrm{A}_k\cos k(\theta-\theta')+\ldots\ldots\ldots$$

with similar quantities for $a^2d_a^2\mathrm{A}$, $aa'd_a\, d'_a\mathrm{A}$, etc.

Therefore, by substituting these values of A, $ad_a\mathrm{A}$, etc., in the expression for R, and collecting the coefficients of the different cosines, we shall have for this part of R,

$$\mathrm{R}=-(\tfrac{1}{2}\mathrm{A}_0+\tfrac{1}{2}ad_a\mathrm{A}_0v+\tfrac{1}{2}a'd_a\mathrm{A}_0v'+\text{etc.}\ldots)$$
$$-(\ \mathrm{A}_1+\ ad_a\mathrm{A}_1v+\ a'd_a\mathrm{A}_1v'+\text{etc.}\ldots)\cos(\theta-\theta')$$
$$\cdot\quad\cdot\quad\cdot\quad\cdot\quad\cdot\quad\cdot\quad\cdot\quad\cdot\quad\cdot\quad\cdot\quad\cdot\quad\cdot\quad\cdot\quad\cdot\quad\cdot\quad\cdot$$
$$-(\ \mathrm{A}_k+\ ad_a\mathrm{A}_kv+\ a'd_a\mathrm{A}_kv'+\text{etc.}\ldots)\cos k(\theta-\theta')$$
$$-\text{ etc.}\ldots\ldots\ldots$$

The expansion of the first part of R is effected in like manner, and it becomes $\frac{a}{a'^2}(1+v-2v'+\text{etc.})\cos(\theta-\theta')$ so that the only part of R which will be affected by the addition of this quantity is the coefficient of $\cos(\theta-\theta')$; adding these quantities together, we may put R under the form

$$\mathrm{R}=-(\tfrac{1}{2}\mathrm{A}_0+\tfrac{1}{2}ad_a\mathrm{A}_0v+\tfrac{1}{2}a'd_a\mathrm{A}_0v'+\text{etc.}\ldots)$$
$$\cdot\quad\cdot\quad\cdot\quad\cdot\quad\cdot\quad\cdot\quad\cdot\quad\cdot\quad\cdot\quad\cdot\quad\cdot\quad\cdot\quad\cdot$$
$$-(\mathrm{A}_k+ad_a\mathrm{A}_kv+a'd_a\mathrm{A}_kv'+\text{etc.}\ldots)\cos k(\theta-\theta')$$
$$-\text{etc.}\ldots\ldots\ldots$$

And in order to obtain terms of the form

$$\mathrm{P}\cos(8nt_2-4n_3-3nt_4+\Pi)$$

we must substitute for v, v', θ, θ', not merely their elliptic values, but their complete values; that is, we must include all terms which they may contain which will produce terms of the required form.

Again, the most convenient form in which R can be

put for reducing it to numbers is by substituting for $ad_a A_k$, $a^2 d_a^2 A_k$, etc., their values in terms of $a' d_{a'} A_k$, $a'^2 d_{a'}^2 A_k$, etc.[1] These are,

$$ad_a A_k = -A_k - a' d_{a'} A_k,\ aa' d_a d_{a'} A_k = -2a' d_{a'} A_k - a'^2 d_{a'}^2 A_k,$$

$$a^2 d_a^2 A_k = -2ad_a A_k - aa' d_a d_{a'} A_k = 2A_k + 4a' d_{a'} A_k + a'^2 d_{a'}^2 A_k,$$

etc.

The quantities A_k, $ad_a A_k$, etc., are also dependent upon the coefficients of the expansion of the quantity

$$\frac{m}{\sqrt{(1 - 2\alpha \cos(\theta - \theta') + \alpha^2)}}$$

where $\alpha = \frac{a'}{a}$, a being greater than a'; and if b_k be the general coefficent of the latter quantity, it is found that

$$A_k = \frac{1}{a} b_k,\ a' d_{a'} A_k = \frac{1}{a} \alpha d_\alpha b_k,\ a'^n d_{a'}^n A_k = \frac{1}{a} \alpha^n d_\alpha^n b_k, \text{ etc.}$$

except in the particular case where n and k are both unity, when they have a different value; but this term does not enter into the present investigation. The terms of this kind which will be wanted in the case of Mars and the Earth, are found to be as follows:—

Numerical values of quantities, etc., in expansion of R.

$$b_4 = .129973 \qquad b_5 = .077170 \qquad b_6 = .046595$$
$$b_7 = .028480$$

$$\alpha d_\alpha b_4 = .60426 \quad \alpha d_\alpha b_5 = .43723 \quad \alpha d_\alpha b_6 = .31104$$
$$\alpha d_\alpha b_7 = .21184$$

$$\alpha^2 d_\alpha^2 b_4 = 2.4881 \quad \alpha^2 d_\alpha^2 b_5 = 2.2148 \quad \alpha^2 d_\alpha^2 b_6 = 1.1918$$
$$\alpha^2 d_\alpha^2 b_7 = 1.5318$$

$$\alpha^3 d_\alpha^3 b_4 = 10.267 \quad \alpha^3 d_\alpha^3 b_5 = 10.527 \quad \alpha^3 d_\alpha^3 b_6 = 10.431$$
$$\alpha^3 d_\alpha^3 b_7 = 9.894$$

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[1] a' is supposed to be less than a.

$$a^4 d^4_a b_4 = 54.72 \quad a^4 d^4_a b_5 = 58.67 \quad a^4 d^4_a b_6 = 60.37$$

$$b_8 = .017565 \qquad a = .6563003$$

$$a d_a b_8 = .15666$$

$$a^2 d^2_a b_8 = 1.2259$$

$$a^3 d^3_a b_8 = 8.701$$

Direct and indirect perturbation.

It must be here observed that the entire perturbation of any of the three planets, say of Mars, for instance, will consist of two distinct parts; first, that caused by the indirect action of Jupiter and the direct action of the Earth, and next, that caused by the indirect action of the Earth and the direct action of Jupiter. Thus, in the first case, if there are certain inequalities in the orbit of Mars produced by the action of Jupiter, the attraction of the Earth upon it will be different to what it would be if there were no such inequalities; the terms arising from this difference are what we mean by those arising from the indirect action of Jupiter and the direct action of the Earth, and so for the second case.

To find terms of the first kind, we must find all those terms in the coördinates both of Mars and the Earth which arise from the simple perturbation of Jupiter and which include the quantity $3n_4t$ in their argument; and must add them to the elliptic values of $r\ r'\ \theta\ \theta'$ in the disturbing function which relates to Mars and the Earth; and to find terms of the latter kind, we must find all terms in the coördinates of Mars and Jupiter which include in their arguments the quantity $4n_3t$. Let us begin with the former, as they appear to be the more important. I find then the following quantities in the coördinates of Mars:—

Inequalities which have to be added to the elliptic values of the coördinates of

$$\left.\begin{aligned} \delta\theta &= .201257'' \sin(4n_3t - 3n_4t + 4\epsilon_3 - 3\epsilon_4 - \varpi_3) \\ \frac{\delta r}{a} &= -.11505'' \cos(4n_3t - 3n_4t + 4\epsilon_3 - 3\epsilon_4 - \varpi_3) \end{aligned}\right\} \ldots\ldots (a)$$

$$\left.\begin{aligned} \delta\theta &= -.01101'' \sin(4n_3t - 3n_4t + 4\epsilon_3 - 3\epsilon_4 - \varpi_4) \\ \frac{\delta r}{a} &= .00929'' \cos(4n_3t - 3n_4t + 4\epsilon_3 - 3\epsilon_4 - \varpi_4) \end{aligned}\right\} \ldots\ldots (a_1)$$

$$\left.\begin{aligned}\delta\theta &= .02465''\sin(4n_3t-3n_4t+4\epsilon_3-3\epsilon_4+109^\circ.1)\\ \frac{\delta r}{a} &= -.008955''\cos(4n_3t-3n_4t+4\epsilon_3-3\epsilon_4+108^\circ.18')\end{aligned}\right\}.(a_2)$$

Mars and the Earth in forming the differential equations.

$$\left.\begin{aligned}\delta\theta &= 1.19503''\sin(3n_3t-3n_4t+3\epsilon_3-3\epsilon_4)\\ \frac{\delta r}{a} &= -.951068''\cos(3n_3t-3n_4t+3\epsilon_3-3\epsilon_4)\end{aligned}\right\}\cdots\cdots\cdots(b)$$

$$\left.\begin{aligned}\delta\theta &= .2623''\sin(3n_3-3n_4t+3\epsilon_3-3\epsilon_4+81^\circ.27)\\ \frac{\delta r}{a} &= -.1068\cos(3n_3t-3n_4t+3\epsilon_3-3\epsilon_4+81^\circ.56')\end{aligned}\right\}..(b_1)$$

$$\left.\begin{aligned}\delta\theta &= 2.3180''\sin(2n_3t-3n_4t+2\epsilon_3-3\epsilon_4+50^\circ.6')\\ \frac{\delta r}{a} &= -1.4776''\cos(2n_3t-3n_4t+2\epsilon_\epsilon-3\epsilon_4+52^\circ.43')\end{aligned}\right\}(c)$$

$$\left.\begin{aligned}\delta\theta &= .195''\sin(2n_3t-3n_4t+2\epsilon_3-3\epsilon_4+20^\circ34')\\ \frac{\delta r}{a} &= -.0889''\cos(2n_3t-3n_4t+2\epsilon_3-3\epsilon_4+20.57')\end{aligned}\right\}\cdots(c_1)$$

$$\left.\begin{aligned}\delta\theta &= 3.3273''\sin(n_3t-3n_4t+\epsilon_3-3\epsilon_4-1^\circ.14')\\ \frac{\delta r}{a} &= -.864''\cos(n_3t-3n_4t+\epsilon_\epsilon-3\epsilon_4-6^\circ.18')\end{aligned}\right\}\cdots\cdots\cdots(d)$$

$$\left.\begin{aligned}\delta\theta &= .1112''\sin(5n_3t-4n_2t+5\epsilon_3-4\epsilon_2-\varpi_3)\\ \frac{\delta r}{a} &= -.0942''\cos(5n_3t-4n_2t+5\epsilon_3-4\epsilon_2-\varpi_3)\end{aligned}\right\}\cdots\cdots\cdot(e)$$

and in the coördinates of the Earth there occur the terms

$$\left.\begin{aligned}\delta\theta' &= .16985''\sin(3n_3t-4n_4t+3\epsilon_3-3\epsilon_4)\\ \frac{\delta r'}{a'} &= -.135103''\cos(3n_3t-3n_4t+3\epsilon_3-3\epsilon_4)\end{aligned}\right\}\cdots\cdots\cdots(f)$$

$$\left.\begin{aligned}\delta\theta' &= .551129''\sin(2n_3t-3n_4t+2\epsilon_3-3\epsilon_4+\varpi_4)\\ \frac{\delta r'}{a'} &= -.3770''\sin(2n_3t-3n_4t+2\epsilon_3-3\epsilon_4+\varpi_4)\end{aligned}\right\}\cdots\cdots(g).$$

Of these quantities the values of $\delta\theta$ in (a) (b) (c) and (e), as also those of $\delta\theta'$ in (f) and (g), are taken from M. Pontécoulant's *Systême du Monde.* The quantities (d) are omitted both by M. Pontécoulant and Laplace, and may therefore seem suspicious, but I have gone over the

calculation of them twice on separate paper, and such appears to be the result. The values $\delta\theta$ and δr in a, are what result from the employment of the equation

$$\frac{r\delta r}{a^2}=-.951''\cos(3n_3t-3n_4t+3\epsilon_3-3\epsilon_4)$$

in the last term of the equation for the radius vector, and in the term $\delta r d_t r$ in that for the longitude; and from the quantity which arises from the division of this value of $r\delta r$ by r, to obtain δr. Equations b, in like manner, are derived from the use of the terms

$$\frac{\delta r}{a}=-1.4776''\cos(2n_3t-3n_4t+2\epsilon_3-3\epsilon_4+52^\circ.43')$$ [3]

and from the corresponding term for $\frac{r\delta r}{a^2}$, which is

$$-1.4717\cos(2n_3t\ldots+54^\circ.12')$$

and the equations (c_1) are derived from the value of the radius vector in (d).

There will also be a minute quantity corresponding to equations (d) in the coördinates of the Earth, the effect of which I find will be slightly to increase the entire value of the inequality, but by no sensible quantity. The only term in the radius vector given by M. Pontécoulant is that in (b); that in (c) agrees pretty closely with that given by Laplace, allowance being made for the difference of the mass of Jupiter adopted by him. The others also which I have added will be found to be pretty correct, as they give values, when substituted in the equations for the longitude, which agree with the terms in longitude given by M. Pontécoulant.

The value of δr in (b), as given by M. Pontécoulant, is given in the form $\delta r=-.0000070256\cos(3n_3t$, etc.). This is expressed not in parts of the radius of the orbit of Mars, but of the Earth, which radius is taken for unity. It must, however, before it can be made use of in the following calculation, be reduced to parts of the radius of the orbit of Mars, which is done by multiplying the right-hand member by aa, which will give

$$\frac{\delta r}{a}=-.0000070256\,a\cos(3n_3t-,\text{ etc.});$$

[3] These values of $r\delta r$ and δr were also employed in finding the term (d).

but as the quantity which finally results from the employment of this term will have to be reduced to seconds, it will be more convenient to express the right-hand member in seconds at once; which is done by multiplying it by $60^3 \frac{3}{\pi}$, and thus arises the quantity in (b). All the terms of δr are given in the same form.

It would somewhat simplify the operations if we were to put the quantities a, a_1, a_2, etc., into combination; but by keeping them separate, we can more easily see how much of the final result is due to each of them, and so may more easily supply any correction that may be necessary in consequence of any inexactness in the terms (a_1), etc.

The following values of the masses, mean motions, and elements of the orbits of the Earth, Mars, and Jupiter, are those which I have made use of; they are taken from M. Pontécoulant (μ is here supposed to be the mass of the Sun): Numerical values of the masses and elements of the Earth, Mars, and Jupiter.

$$m_2 = \frac{\mu}{356354} \qquad m_3 = \frac{\mu}{2680337} \qquad m_4 = \frac{\mu}{1054}$$

$$n_2 = 1295977.37'' \quad n_3 = 689051.08'' \quad n_4 = 109256.59''.$$

$$\varepsilon_2 = 100^\circ.23'32'' \quad \varepsilon_3 = 232.49.50 \quad \varepsilon_4 = 81.52.10$$

$$e_2 = .0168536 \quad e_3 = .093306 \quad e_4 = .0481621$$

$$\varpi_2 = 99^\circ.30 \quad \varpi_3 = 332.23.40 \quad \varpi_4 = 11.7.36$$

also if γ be the inclination of the orbit of Mars to the ecliptic, and α_1 the longitude of the ascending node, $\gamma = 1^\circ.50'$ $\alpha_1 = 48^\circ$. Calculation of the inequality resulting from equations (a), (a_1), (a_2).

Let us begin by determining that part of the inequality which is due to the terms in equation (a).

$$\text{Let } R = \tfrac{1}{2}R_0 + R_1 \cos(\theta - \theta') + \ldots + R_4 \cos 4(\theta - \theta').$$

Now it is evident that the terms in equation (a) will produce a quantity of the required form by combination with the angle $4n_3t - 4n_2t$; the part of R therefore which we shall want is $R_4 \cos 4\,\overline{\theta - \theta'}$. Now, by substituting for

θ its value increased by the quantity given in (a), viz.:—

$$n_3t+\epsilon_3+\ldots+.201257'' \sin(4n_3t-3n_4t+4\epsilon_3-3\epsilon_4-\varpi_3)$$

we shall obtain the term

$$\cos 4\,\overline{\theta-\theta'}=\cos(4n_3t-4n_2t+4\epsilon_3-4\epsilon_2)$$

$$+\ 402514''\cos(8n_3t-4n_2t-3n_4t+8\epsilon_3-4\epsilon_2-3\epsilon_4-\varpi_3);$$

$$\text{also } R_4=-m'(A_4+ad_aA_4v)=-m'(A_4-\overline{A_4+a'd_{a'}A_4}v)$$

$$=-m'\left\{A_4+\overline{A_4+a'd_{a'}A_4}.11505''\cos(4n_3t-3n_4t\right.$$
$$\left.+4\epsilon_3-3\epsilon_4-\varpi_3)\right\}$$

(by substituting for v the value given in (a)); therefore, by multiplying by the value of $\cos(4\,\theta-\theta')$ we shall have

$$R=-m'\left(.402514''A_4-\tfrac{1}{2}(A_4+a'd_{a'}A_4).11505''\right)$$
$$\cos(8nt,\ldots\text{etc.});$$

$$\text{for } A_4 \text{ and } a'd_{a'}A_4 \text{ write their values } \frac{1}{a}b_4,\ \frac{1}{a}ad_ab_4;$$

$$\text{or } \frac{1}{a}.129973 \text{ and } \frac{1}{a}.60426 \text{ and we shall find}$$

$$R=-\frac{m'}{a}.094552''\cos(8n_3t-4n_2t-3n_4t\ldots-\varpi_3)$$

We have now to form the function $\dfrac{3}{a'n}\int_t\int_t d_t(R)$, and in doing so we must be very careful in this and all other occasions of the kind, to remember which of the quantities $8n_3t$, etc., belong to the coördinates of the disturbed planets, since the quantity $d_t(R)$ means that R is to be differentiated with respect to the disturbed planet only. In this case, since the inequality (a), viz.:—

$\sin(4n_2t-3n_4t-$, etc.), belongs to the coördinates of Mars, it is evident that the terms $8n_3t-3n_4t$ belong to Mars.

Let $8n_3t-4n_2t-3n_4t+8\varepsilon-4\varepsilon_2-3\varepsilon_4=\lambda$, then, bearing in mind what has just been said, we shall have

$$\frac{3}{a^2n_3}\int_t\int_t d_t(\mathrm{R})=-\frac{3m'}{a^2n_3}\frac{8n_3-3n_4}{(8n_3-4n_2-3n_4)^2}\frac{1}{a}.094552''$$
$$\times\sin(\lambda-\varpi_3)=\delta\theta$$

which may be put under the form

$$-\frac{3m'}{n_3^2a^3}\cdot\frac{8n_3-3n_4}{n_3}\frac{n_3^2}{(8n_3-4n_2-3n_4)^2}.094552''\sin(\lambda-\varpi_3)$$

or since $n^2a^3=\mu$, μ being the mass of the Sun,

$$\delta\theta=-\frac{m'}{\mu}3.\frac{(8n_3-3n_4)}{n_3}\left(\frac{n_3}{8n_3-4n_2-3n_4}\right)^2.094552''$$
$$\times\sin(\lambda-\varpi_3).$$

To reduce this to numbers, we have

$\frac{m'}{\mu}=\frac{1}{356354}$; log. $356354=5.5518817$.

$n_3=689051.08''$ $n_4=109256.59$ $n_2=1295977.37$.

$\therefore 8n_3-3n_4=5184638.87$

log. $8n_3-3n_4=6.7147185$
log. $n_3\qquad=5.8382513$

$.8764672=\log.\frac{8n_3-3n_4}{n_3}$;

also, $8n_3-3n_4=5184638.87''$
$4n_2\qquad=5183909.48''$

$\therefore 8n_3-3n_4-4n_2=\qquad 729.39''$

$$
\begin{array}{rl}
\log.\ n_3 = & 5.8382513 \\
\log.\ 729.39 = & 2.8629598 \\
\hline
& \dfrac{2.9752915}{2} = \log.\ \dfrac{n_3}{8n_3-3n_4-4n_2} \\
\hline
& 5.9505830 = \log.\left(\dfrac{n_3}{8n_3-3n_4-4n_2}\right)^2 \\
\log.\ 3 = & .4771213 \\
& .8764672 = \log.\dfrac{8n_3-3n_4}{n_3} \\
\hline
& 7.3041715 \\
\text{subtract } \log.\ 356354 = & 5.5518817 \\
\hline
& 1.7522898
\end{array}
$$

$$
= \log.\ 3\,\frac{m'}{\mu}\,\frac{8n_3-3n_4}{n_3}\left(\frac{n_3}{8n_3-3n_4-4n_2}\right)^2.
$$

As this multiplier is common to all the terms which occur in the direct perturbation of Mars by the Earth, it will be very useful. Adding to it the logarithm of .094552, (the remaining part of the multiplier of sin $(\lambda-\varpi_3)$) which is

$$
\begin{array}{l}
\bar{2}.9756707 \\
1.7522898 \\
\hline
\end{array}
$$

we have $.7279605 = \log.\ 5.345$; hence this term gives

$$\delta\theta = -5.345'' \sin(\lambda-\varpi_3) \ldots\ldots (A).$$

In like manner, equations a_1 and a_2 give respectively

$$\delta\theta = -.354'' \sin(\lambda-\varpi_4) \ldots\ldots (A_1)$$

$$\delta\theta = -.548'' \sin(\lambda+108.32) \ldots\ldots (A_2).$$

As the period of this inequality is very long, for very great exactness it would be necessary to take into account the variations of the elements of the orbits. The principal effect of this variation is to lengthen the period of the inequality, and this is equivalent to causing a small diminution of the divisor, which would somewhat increase the amount of the inequality; in fact, it appears to be increased by about a twenty-fourth of its whole amount.

But then, on the other hand, as the eccentricity of Mars is not very small, we ought also, for great accuracy, to take into account the higher powers of the eccentricities. The complete calculation of such terms would be very complicated; but it appears that by taking them into account the entire amount would be diminished by much about the same quantity by which it would be increased by taking into account the variations of the elements. Also the angles between the major axes of the planets are slowly varying; that between the axes of Mars and Jupiter, for instance, is slowly diminishing. The effect of this would be to cause a slight diminution in the value of such quantities as equation (*c*). But then, on the other hand, the eccentricities of both the orbits are on the increase, which would tend to increase the quantity; so that it will be seen that the change which it would undergo during one period or more of the long inequality, whether for greater or less, will be extremely small, and may be neglected. So that it would seem that if the work is correct, the first approximate value obtained as above will be a very exact one, quite as exact as is usually obtained, and will serve for one period or more, without sensible error; the error committed will certainly not amount to a second for Mars, or to more than a very small fraction of one for the Earth. It may also be not out of place to notice, that in determining the mass of Mars, from the comparison of the observed value of the perturbations caused by it with their theoretical value, since the latter are generally somewhat smaller when the higher powers of the eccentricities are taken into account, it follows that the mass of Mars, which would result from this comparison, when they are taken into account, will be most likely somewhat larger than if they were omitted.

The values of $\delta\theta$, above given, are those which result simply from the function $\int_t\int_t d_t(\mathrm{R})$, which is twice divided by the very small divisor .0010585, this being the value of the quantity $\dfrac{8n_3-3n_4-4n_2}{n_3}$. The terms which would arise from the other terms in the equation for the longitude, $2\int_t rd_r\mathrm{R}$, for instance, will be quite insensible.

Terms resulting from (b) and (b_1).

The argument of these is $3n_3t-3n_4t$; and hence the quantity λ will result from the combination of these with the angles, Inequalities resulting

from equations (b) and (b_1). $4n_3t-4n_2t$, n_4t; and with $5n_3t-5n_2t$, n_4t.

let $n_2t+\epsilon_2=\phi_2$, etc. Then if in the terms belonging to R,

$R_4\cos 4\,\overline{\theta-\theta'}$, and $R_5 \cos 5\,\overline{\theta-\theta'}$, we substitute for r r' and θ θ', their values

$$r_3=a\Big(1-e_3\cos(\phi_3-\varpi_3)-.951068''\cos(3\phi_3-3\phi_4)\Big)$$

$$r'=a'\,(1-e_2\cos\overline{\phi_2-\varpi_2})$$

$$\theta_3=\phi_3+2e_3\sin(\phi_3-\varpi_3)+1.19503''\sin(3\phi_3-3\phi_4)\Big)$$

$$\theta'=\phi'+2e_2\sin(\phi'-\varpi_2)$$

we shall obtain

$$R=-m'(9A_4+a'd_{a'}A_4)\,1.19503''\,e_3\cos(\lambda-\varpi_3)$$

$$-m'\tfrac{1}{4}(10A_4+12a'd_{a'}A_4+a'^2d^2_{a'}A_4).951068''\,e_3\cos(\lambda-\varpi_3)$$

$$+\frac{5}{4}m'(10A_5+a'd_{a'}A_5)1.19503''\,e_2\cos(\lambda-\varpi_2)$$

$$+\tfrac{1}{4}m'(10A_5+12a'd_{a'}A_5+a'^2d^2_{a'}A_5).951068''\,e_2\cos(\lambda-\varpi_2)$$

$$=-.44269''\frac{m'}{a}\cos(\lambda-\varpi_3)+06342''\frac{m'}{a}\cos(\lambda-\varpi_2)$$

$$=-.48361''\frac{m'}{a}\cos(\lambda+33^\circ.\,37'),$$

we have now to form the function $\dfrac{3}{a^2n_3}\int_t\int_t d_t(R)$ with this value of R, just as was done above; and by doing so, we obtain the term

$$\delta\theta=-27.339''\sin(\lambda+33^\circ.\,37')\ldots\ldots(B).$$

And by the same process the equations (b_1) give

$$\delta\theta=4.380''\sin(\lambda+115^\circ.\,21')\ldots\ldots(B_1).$$

Inequality re- Term depending upon (c) and (c_1).

The terms (c) and (c_1) it is easily seen will have to be

multiplied by the squares of the eccentricities and inclinations: for simplicity we shall calculate these two parts separately. Then by making use of the terms (c) we find

sulting from equations (c) and (c_1).

$$R = -\frac{m'}{4}(104A_4 + 22a'd_{a'}A_4 + a'^2d^2_{a'}A_4)$$

$$\times 2.3180''\, e_3^2 \cos(\lambda - 2\varpi_3 + 50°.\,6')$$

$$+\frac{m'}{8}(550A_5 + 110a'd_{a'}A_5 + 5a'^2d_{a'}A_5)$$

$$\times 2.3180''\, e_3 e_2 \cos(\lambda - \varpi_3 - \varpi_2 + 50°.\,6')$$

$$-\frac{m'}{8}(342A_6 + 66a'd_{a'}A_6 + 3a'^2d^2_{a'}A_6)$$

$$\times 2.3180''\, e_2^2 \cos(\lambda - 2\varpi_2 + 50°.\,6')$$

$$-\frac{m'}{16}(126A_4 + 174Aa'd_{a'}A_4 + 27a'^2d^2_{a'}A + a'^3d^3_{a'}A_4)$$

$$\times 1.4776''\, e_3^2 \cos(\lambda - 2\varpi_3 + 52°.\,43')$$

$$+\frac{m'}{8}(120A_5 + 166a'd_{a'}A_5 + 26a'^2d^2_{a'}A_5 + a'^3d^3_{a'}A_5)$$

$$1.4776''\, e_2 e_3 \cos(\lambda - \varpi_2 - \varpi_3 + 52°.\,43')$$

$$-\frac{m'}{16}(114A_6 + 158a'd_{a'}A_6 + 25a'^2d^2_{a'}A_6 + a'^3d^3_{a'}A_6)$$

$$1.4776''\, e_2^2 \cos(\lambda - 2\varpi_2 + 52°.\,43')$$

which terms, reduced to numbers and put into combination, give $R = -\frac{m}{a}.36754'' \cos(\lambda + 118°.\,41)$, which, integrated, etc., gives

$$\delta\theta = -20.7774'' \sin(\lambda + 118°.\,41').$$

The part arising from the inclination of the orbit of Mars to the ecliptic appears to amount to only $-.0962''$ $\sin(\lambda - 45°)$, which, united with the former, gives

$$\delta\theta = -20.583'' \sin(\lambda + 118°.\,37') \ldots\ldots (C)$$

Inequality resulting from equation (*d*).

and by the same process the terms (c_1) give

$$\delta\theta = -1.490'' \sin(\lambda + 88^\circ.\,7') \ldots\ldots (C_1).$$

It will be seen that in the part of R introduced by the term in the radius vector, the coefficients of the quantities A_4, A_5, A_6, decrease in arithmetical progression, as also do those of $a'd_{a'}A_4$, etc.

Calculation of the term depending upon (*d*). This term is multiplied by the cubes of the eccentricities. Hitherto the terms have been obtained by the actual substitution of the true coördinates of Mars in R; and we might calculate the following term by the same method, but another way is preferable. For, since the elliptic values of the expansion of R have been already calculated, and tables of them formed (See Pontécoulant, *Systéme du Monde*, vol. iii.) it will save trouble, in cases where higher powers of the eccentricities have to be employed, if we can deduce the complete value of R from its elliptic value, just as this is itself deduced from the value which it would have, supposing the eccentricities were 0.

Let then R′ be the elliptic value of R; then if R be the complete value, it is evident that R is what R′ becomes when r and θ become $r + \delta r$, $\theta + \delta\theta$; therefore, by the differential calculus, $R = R' + d_\theta R'\delta\theta + d_r R'\delta r$; the only parts of which will be wanted are the two latter. The calculation of the first of them is very simple, for if in general $R' = R'_0 + \ldots\ldots + R'_k \cos\overline{\theta - \theta'}$, we shall have $d_\theta R = -kR_k \sin k\overline{\theta - \theta'}$, that is, it will be the same as the corresponding term of R′, but multiplied by $-k$, and with sin instead of cos. Now the term $R'_4 \cos\overline{4\theta - \theta'}$ will contain the term

$$-\frac{m}{48}(1471A_4 + 447a'd_{a'}A_4 + 39a'^2d^2_{a'}A_4 + a'^3d^3_{a'}A_4)$$

$$\times e_3^3 \cos(7\phi_3 - 4\phi_2 - 3\varpi_3)$$

$$= P\cos(7\phi_3 - 4\phi_2 - 3\varpi_3), \text{ suppose};$$

then we shall have by what has gone before,

$$d_\theta R' = -4P\sin(7\phi_3 - 4\phi_2 - 3\varpi_3);$$

let this now be multiplied by $\delta\theta$, or by its value 3.3273″ sin $(\phi_3-3\phi_4-1^\circ.14)$, and we shall have, on restoring the value of P, $d_\theta R'\delta\theta$

$$=-\frac{m'}{24}(1471A_4+447a'd_{a'}A_4+39a'^2d^2_{a'}A_4+a'^3d^3_{a'}A_4)$$

$$\times 3.3273''\, e_3^3 \cos(\lambda-3\varpi_3-1^\circ.14).$$

and in like manner we shall have for the remaining terms

$$+m'\frac{5}{32}(1490\,A_5+435a'd_{a'}A_5+38\,a'^2d^2_{a'}A_5+a'^3d^3_{a'}A_5)$$

$$\times 3.3273''\, e_3^2\, e_2 \cos(\lambda-2\varpi_3-\varpi_2-1^\circ.14)$$

$$-m'\frac{3}{16}(1482\,A_6+422\,a'd_{a'}A_6+37\,a'^2d^2_{a'}A_6+a'^3d^3_{a'}A_6)$$

$$\times 3.3273''\, e_3\, e_2 \cos(\lambda-\varpi_3-2\varpi_2-1^\circ.14')$$

$$+m'\frac{7}{96}(1456\,A_7+408a'd_{a'}A_7+36a'^2d^2_{a'}A_7+a'^3d^3_{a'}A_7)$$

$$\times 3.3273''\, e_2^3 \cos(\lambda-3\varpi_2-1^\circ.14'),$$

which terms, reduced to numbers and put into combination and integrated, etc., give the term

$$\delta\theta=-4.874''\sin(\lambda+99^\circ.37').$$

The finding of the term $d_rR'\delta r$ is somewhat more complicated; it is done thus: $d_rR'=d_aR'd_ra$, or if $r=a\overline{1+v}$ $d_ar=1+v=\frac{r}{a}\therefore d_rR'=d_aR'\frac{a}{r}$. (M. Pont., vol. iii., p. 20).

$$\text{Also, } \frac{a}{r}=1+e\cos\overline{\phi-\varpi}+e^2\cos\overline{2\phi-2\varpi}$$

$$+\frac{9}{8}e^3\cos\overline{3\phi-3\varpi}.$$

Hence we must find all terms in R′, which, when multiplied by this, will give terms of the form cos $(7\phi_3-4\phi_2)$, since this is the quantity which by combination with the

terms in equations (d), will produce a term of the required form; and first for those terms which contain only the eccentricity of Mars.

These will be,

$$R' = -m' A_4 \cos \overline{4\phi_3 - 4\phi_2}$$

$$-\frac{m'}{2}(9A_4 + a'd'_a A_4)\, e_3 \cos(5\phi_3 - 4\phi_2 - \varpi_3)$$

$$-\frac{m'}{8}(104A_4 + 22a'd_{a'}A_4 + a'^2 d^2_{a'} A_4)\, e_3^2 \cos(6\phi_3 - 4\phi_2 - 2\varpi_3)$$

$$-\frac{m'}{48}(1471A_4 + 447a'd_{a'}A_4 + 39a'^2 d^2_{a'} A_4 + a'^3 d^3_{a'} A_4)$$

$$\times e_3^3 \cos(7\phi_3 - 4\phi_2 - 3\varpi_3)$$

also, $d_a R' = -\frac{R'}{a} - \frac{1}{a} a'd_{a'}R$; and by differentiating the above value of R, we have

$$-\frac{1}{a} a'd_{a'}R = \frac{m'}{a} a'd'_a A_4 \cos(4\phi_3 - 4\phi_2)$$

$$+\frac{m'}{2a}(10a'd_{a'}A_4 + a'^2 d^2_{a'} A_4)\, e_3 \cos(5\phi_3 - 4\phi_2 - \varpi_3)$$

$$+\frac{m'}{8a}(126a'd_{a'}A_4 + 24a'^2 d^2_{a'} A_4 + a'^3 d^3_{a'} A_4)$$

$$\times e_3^2 \cos(6\phi_3 - 4\phi_2 - 2\varpi_3)$$

$$+\frac{m}{48a}(1918a'd_{a'}A_4 + 525a'^2 d_{a'} A_4 + 42a'^3 d^3_{a'} A_4 + a'^4 d^4_{a'} A_4)$$

$$\times e^3 \cos(7\phi_3 - 4\phi_2 - 3\varpi_3).$$

Therefore, by taking the sum of $R' + a'd_{a'}R$, we have

$$d_a R' = \frac{m'}{a}(A_4 + a'd_{a'}A_4) \cos(4\phi_3 - 4\phi_2)$$

$$+\frac{m'}{2a}(9A_4+11a'd_{a'}A_4+a'^2d^2_{a'}A_4)\,e_3\cos(5\phi_3-4\phi_2-\varpi_3)$$

$$+\frac{m'}{8a}(104A_4+148a'd_{a'}A_4+25a'^2d^2_{a'}A_4+a'^3d^3_{a'}A_4)$$

$$\times e_3^2\cos(6\phi_3-4\phi_2-2\varpi_3)$$

$$+\frac{m'}{48a}(1471A_4+2365a'd_{a'}A_4+564a'^2d^2_{a'}A+43a'^3d^3_{a'}A_4$$

$$\times a'^4d^4_{a'}A_4)\,e_3^3\cos(7\phi_3-4\phi_2-3\varpi^3);$$

therefore, multiplying this by $\frac{a\delta r}{r}$, or by its value

$$-(1+e_3\cos\overline{\phi_3-\varpi_3}+e_3^2\cos\overline{2\phi_3-2\varpi^3}+\frac{9}{8}e_3^3\cos\overline{3\phi_3-3\varpi_3})$$

$$\times a\,.864''\cos(\phi_3-3\phi_4-6°.\,18');$$

we have for the part of R depending on the powers of the eccentricity of Mars only,

$$d_r R'\delta r=-\frac{m'}{96}.864''(1918A_4+2968a'd_{a'}A_4+651a'^2d'^2_{a}A_4$$

$$+46a'^3d^3_{a'}A_4+a'^4d^4_{a'}A_4)\,e_3^3\cos(\lambda-3\varpi_3-6°.\,18')$$

and, in like manner, the remaining terms of R depending upon e_3^2, e_2, etc., are

$$+\frac{m'}{32}.864''(1750A_5+2716a'd_{a'}A_5+603a'^2d^2_{a'}A_5$$

$$+44a'^3d^3_{a'}A_5+a'^4d^4_{a'}A_5)\,e_3^2e_2\cos(\lambda-2\varpi_3-\varpi_2-6°.\,18'$$

$$-\frac{m'}{32}.864''(1596A_6+2484a'd_{a'}A_6+558a'^2d^2_{a'}A_6$$

$$+42a'^3d^3_{a'}A_6+a'^4d^4_{a'}A_6)\,e_3e_2^2\cos(\lambda-\varpi_3-2\varpi_2-6°.\,18')$$

$$+\frac{m'}{96}.864''(1456A_7+2272a'd_{a'}A_7+516a'^2d^2_{a'}A_7$$

$$+40a'^3 d^3_{a'} A_7 + a'^4 d^4_{a'} A_7)\, e_2^3 \cos(\lambda - 3\varpi_2 - 6^\circ.\,18'),$$

which being reduced to numbers and put into combination and integrated, etc., give

$$\delta\theta = -2.228 \sin(\lambda + 91^\circ.\,56'),$$

which united with the part previously found, gives

$$\delta\theta = -7.101'' \sin(\lambda + 97^\circ.\,10') \ldots\ldots (\text{D.})$$

It will here be seen that the coëfficients of the quantities A_4, A_5, etc., are not in arithmetical progression, as they were in a former case; but here the *first differences* of the coëfficients are in arithmetical progression, as are also those of $a'd_{a'}A_4$, $a'd_{a'}A_5$, etc., these differences being respectively, 168, 154, 140; 252, 232, 212; 48, 45, 42. The remaining ones are in arithmetical progression. This may serve as a sort of test of their correctness. This method was also used to verify the results, equations (c). The part depending upon the inclination of the orbits is of no importance. The term depending upon (e) will be omitted for the present.

Inequalities resulting from equations (f) and (g). The remaining terms, *i. e.* those depending upon (f) and (g), belong to the coördinates of the Earth; and therefore we must remember that in the differentiation of R, $8n_2t$ is the only part which belongs to the coördinates of Mars; also, the terms in the expansion of R, which will be required, are,

$$R_6 \cos 6\,\overline{\theta - \theta'} \quad R_7 \cos 7\,\overline{\theta - \theta'}. \quad R_8 \cos 8\,\overline{\theta - \theta'}.$$

The term arising from (f) appears to be

$$\delta\theta = 2.194'' \sin(\lambda + 33^\circ.\,16') \ldots\ldots (\text{F}),$$

and that from (g) is

$$\delta\theta = 4.749'' \sin(\lambda + 78^\circ.\,2') \ldots\ldots (\text{G.})$$

Combination of these inequalities. The terms above found appear to be the only ones of any importance in the direct mutual perturbation of Mars and the Earth; collecting them and putting them into combination, we have for the inequality of Mars, produced by the direct action of the Earth,

$$\delta\theta_3 = -44.442'' \sin(\lambda + 75°.\ 14').$$

The corresponding quantity for the Earth will be found very approximately by multiplying this by $-\frac{m_3}{m_2}\sqrt{\frac{a_3}{a_2}}$; the logarithm of this latter quantity is

$\bar{1}.2151410$, that of $44.442''$ is 1.6477936; therefore we

obtain by addition

$$\begin{array}{r} \bar{1}.2151410 \\ 1.6477936 \\ \hline .8629346 \end{array} = \log.\ 7.293'';$$

hence for the Earth

Total result for the Earth.

$$\delta\theta_2 = 7.293'' \sin(\lambda + 75°.\ 14'). \quad (1.)$$

It only remains to consider the effect of the terms in equations (e). We are now engaged with the direct action of Jupiter upon Mars, and therefore must remember that the quantity $8\phi_3 - 4\phi_2$ now belongs to the coördinates of Mars. The term resulting from (e) appears to be

$$\delta\theta_3 = -1.815'' \sin(\lambda - \varpi_3) \ldots\ldots (\mathrm{E})$$

which, united with the value of $\delta\theta_3$, above found, gives for the entire perturbation in the longitude of Mars,

Total result for Mars.

$$\delta\theta_3 = -45.684'' \sin(\lambda + 73°.34'). \quad (2.)$$

There will also be a term of the same form in the longitude of Jupiter, but it will be perfectly insensible.

Also, the term in $r\delta r$ corresponding to this, will produce, by substitution in the function $\frac{3}{2} e r \delta r \cos \overline{\phi_3 - \varpi_3}$, etc., the terms in the longitude of Mars

$$\delta\theta_3 = -4.262'' \sin(7\phi_3 - 4\phi_2 - 3\phi_3 + 45°.\ 57'). \quad (3.)$$

$$+4.262'' \sin(9\phi_3 - 4\phi_2 - 3\phi_3 + 101°.\ 11'). \quad (4.)$$

To the former of these will have to be added a few small terms, arising from the substitution of the quantities (a), (b), etc., in the differential equations; but they are so mi-

nute that they may be neglected. Also, corresponding to these two latter equations, there will be the term in the radius vector

$$\delta r_3 = 213'' \cos(7\phi_3 - 4\phi_2 - 3\phi_3 + 45°.57')$$

$$-2.13'' \cos(7\phi_3 - 4\phi_2 - 3\phi_3 + 101°.11')$$

Amount of the Earth's displacement at the present time.

It must be mentioned that t is supposed here to commence with the year 1800.

It may be worth while to see how the present position of the Earth is affected by the above inequality. This will be done by substituting for n_3, e_3, etc., their numerical values. The values of e_3, etc., for the year 1800 are $\epsilon_3 = 230°.49'.50''$, $\epsilon_2 = 100.23.32$, $\epsilon_4 = 81.52.10$, then $8\epsilon_3 = 1862°. 38'. 40''$, $4\epsilon_2 = 401.38.8$, $3\epsilon_4 = 245.32.30$, by means of these values and those of n_3, etc., previously given

$$\delta\theta_2 = 7.293'' \sin(729.39t + 210°.46'),$$

$$\text{or} - 7.293'' \sin(729.39t + 30°.46'),$$

from which we see that the Earth is at present behind its mean place; and by making $t=57$, we shall find that for the beginning of this year $\delta\theta = -7.293'' \sin 43°.58' = -5.06''$, which gives the quantity by which it is in arrear of its mean place.

The time when it was at its mean place will be found by making $729.39''t + 30°.46' = 0$, which will give $t = -151.8$, that is, it was at its mean place about 151.8 years before the year 1800, or about 209 years ago; since which time it would appear to have fallen back about 5″, and it will attain its greatest negative value in about 240 years after this, and the motion will then begin to be accelerated.

As the period of this inequality is very long, and its amount small, it will take a long course of the most careful observations to determine the circumstances of it, or even to detect its existence at all: nevertheless, if it is correct, it may ultimately be done with quite as much certainty and accuracy as any other inequality of the same amount in which the period was shorter. Of the three bodies which are principally affected by it, that in which it will probably be by far the most considerable, is the Moon; and, consequently, it would seem that this is the body in

which it will be most easily detected by observation. Before going to the calculation of any other inequalities which exist, it may be well to make a few remarks upon the one which has been just examined. It is remarkable not only for the facts that have been mentioned, such as its effects upon the motion of the Moon, etc., but for the extreme smallness of the quantities which produce it. Mars is one of the smallest of the planets, and the inequalities in its motion, which give rise to it, are very minute. There appears to be a small inequality of long period in the motion of the Earth produced by the long inequality of Jupiter and Saturn, which, though it does not appear to amount to more than about the third of a second, as its period is about 900 years, may have a sensible effect on the motion of the Moon. It is needless to give the calculation at length; but the following terms, taken from M. Pontécoulant, are the principal ones which produce it. In the coördinates of Jupiter, we have

Small inequality in the motion of the Earth.

$$\delta\theta = -1187'' \sin(5\phi_5 - 2\phi_4 + 3^\circ\ 40')$$

$$-161'' \sin(5\phi_5 - 3\phi_4 - 58^\circ.\ 11')$$

$$\delta r = -.000292 \cos(5\phi_5 - 2\phi_4 - 15^\circ.33')$$

$$-.00202 \cos(5\phi_5 - 3\phi_4 - 58^\circ.\ 7');$$

and in those of Saturn,

$$\delta\theta = -2906'' \sin(5\phi_5 - 2\phi_4 + 3^\circ.\ 38')$$

$$+652.59'' \sin(4\phi_5 - 2\phi_4 - 59^\circ.34')$$

$$\delta r = -.00095 \cos(5\phi^5 - 2\phi_4 + 32^\circ.32')$$

$$+01479 \cos(4\phi_5 - 2\phi_4 - 59^\circ.\ 28').$$

The values of δr here given are expressed in parts of the radius of the Earth's orbit.

All these quantities together appear to produce the inequality in the orbit of the Earth

$$\delta\theta = -.354'' \sin(5\phi_5 - 2\phi_4 - 34^\circ.50'). \quad (5.)$$

There are many other combinations of terms like these, which produce small divisors, but nò others that I have

found in the case of the Earth, which seem to be of importance. As, for instance, the terms depending upon

$$3\phi_1-7\phi_2+4\phi_3, \text{ and upon } 5\phi_1-6\phi_2-4\phi_3.$$

These, as well as others which there are, may perhaps produce an inequality of a few seconds in the Moon's motion, and so, perhaps, may be worth examination; otherwise they are of no importance. The former appears to amount to about one-fourth of a second; the latter is still less.

The principal steps in the calculation of the terms depending on $2\phi_4-6\phi_5+3\phi_6$, mentioned above, and upon $\phi_5-4\phi_6+2\phi_7$, as well as one or two involving the coördinates of four planets, will be given in a future number.

Art. II.—*On the Physical Structure of the Earth.* By Henry Hennessy.

The figure of the Earth proves it to have been once in a state of fluidity.

THAT our planet was once in a condition of complete fluidity, is clearly indicated by what Alexander von Humboldt has so happily called the greatest of all geognostical phenomena, the flattening of the earth towards its poles, and its outswelling towards the equator. While the labours of mathematical investigators, since the time of Newton, have rendered more evident the explanation of this phenomenon by the fundamental principles of mechanics, the estimate of its absolute amount has been found more and more coincident with the results of observation. Playfair and Sir John Herschel have, it is true, pointed out the possibility of the earth acquiring a spheroidal shape from the abrading action of its liquid coating; but neither of these philosophers have followed out all the consequences flowing from the mechanical conditions of the problem they had stated. The prominent position given to their views, in connexion with certain geological theories, and especially by one of the ablest writers of the present day,[1] induced me some years ago to give some attention to the question.[2] By the aid of deve-

Imperfect attempts to explain the Earth's figure without the hypothesis of fluidity.

[1] See Lyell's Principles of Geology, chap. 18, seventh ed.; chap. 31, ninth ed.

[2] Proceedings of the Royal Irish Academy, vol. iv., p. 333.

lopments in series of Laplace's coefficients, I obtained a mathematical expression for the equilibrium of the watery coating of the abraded spheroid. This expression contains terms depending on the density of land and water, and on the mean density of the earth. Among other results deduced from it, it appears that on the abrasion theory, the difference between the equatorial and polar axes of the fluid covering of the earth, could not exceed $\frac{1}{403\cdot 6}$ of its mean radius. Observation shows that its true value is about $\frac{1}{300}$, and thus we are compelled to regard the abrasion theory of the earth's figure as inadequate to satisfy all the requirements of a perfect theory.

The former fluid state of the Earth resulting from intense heat.

In proceeding to consider the general structure of the earth, it may thus be fairly assumed that it was at one time in a fluid state, in other words, that it was in a state of fusion from intense heat. It is difficult to conceive any other means of satisfying the condition of fluidity; and direct observations, in every instance that they have been made, clearly prove the existence of a temperature, at points not far below the surface of our planet, which would suffice to melt nearly every substance coming under our notice.

Process of solidification of the Earth.

If the physical properties of the substances existing in the earth's interior do not essentially differ from those which come under our observation, it is possible to arrive at an approximate knowledge of the internal structure of our planet by studying the physical and mechanical changes which would take place during the solidification of substances in a fused state. The fused matter composing the earth would at first evidently consist of a series of spheroidal layers of equal pressure and density, arranged symmetrically around their common centre, the density of each layer increasing with the pressure from the surface to the centre. If pressure were very effective in solidifying the matter of the earth, it might be possible that solidification would commence at the centre. But as yet we have no reason to conclude that great pressure and great density of fused matter may not be inconsistent with its state of fluidity. This is rendered still more manifest by certain conclusions deduced from the dynamical theory of heat, which I have communicated to the British Association.[3] The experiments of M. Cagniard de Latour show that certain gases and vapours may acquire the density of

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[3] See Athenæum, September 5, 1857, p. 1120.

liquids, while still retaining their aeriform condition, provided that the temperature continues extremely high. But, even allowing the possibility of the formation of a solid nucleus from the influence of pressure at the centre of the Earth, where the pressure on the fluid would be greatest, it will soon appear that this nucleus could not long exist under the conditions accompanying the solidification of the superficial parts of the fluid. If we define the solid crust of the Earth as that portion of it which would be laid bare by stripping off all the rocks evidently deposited as sedimentary formations, experiment proves that when the rocks composing the crust of the Earth, as thus defined, are reduced by heat to a fluid condition, and then allowed to solidify, they contract in volume to a very considerable extent. The density of the solidifying portions will be thus considerably increased, and the first effect of refrigeration on the superficial stratum of the fused mass will therefore be, to cause portions of that stratum to sink downwards through the next adjoining stratum, until they arrive at another of equal density with themselves. The extremely small conducting power of such fused matter will permit us to entirely neglect the direct influence of conduction between such portions of the fluid as are not in close contact; consequently the cooling of the remaining strata will take place chiefly by the influence of the descending solidified portions. The portions of the fluid so cooled by contact would also tend to change their positions and to descend in a similar manner. A process of convection would thus take place at the surface of the fluid, but the following causes would tend to impede its propagation towards the interior of the mass:—

Definition of the solid crust of the Earth in the present inquiry.

1. The fluid rendered dense by refrigeration would descend into strata successively denser from compression.

2. The passage of the cooled matter through these strata would tend to make them still more dense.

3. The densities of the portions descending from the surface, would be diminished by the increase of their own temperature from contact with strata nearer to the centre.

Why solidification should commence at the surface so as

From these actions, not only would the cooled portions of the superficial strata of the fluid come more quickly in contact with strata of the same density, below which they could not further descend, but also, their motions would be more resisted in proportion to the density of the strata passed through; and thus the energy of the process of convection, unlike the same process in a perfectly homogeneous

and limpid fluid, such as we see it exhibited in the familiar phenomenon of water boiling, would rapidly diminish from the surface of the spheroid towards its centre. The principal oscillations of the fluid, owing to convection, would therefore take place near the surface. The viscidity of the igneous fluid, just before entering the solid state, would interpose so great an obstacle to the descent of the solid masses formed on its surface, as to allow them to remain floating sufficiently long to become aggregated into more or less continuous sheets, enveloping the fluid matter below. The manner in which stones are supported when thrown on the viscous surface of the fused matter flowing from the crater or sides of a volcano during an eruption, has been long since remarked by Spallanzani[4] and other observers. And it is from this peculiarity of the lava that the portion still fluid is capable of supporting even detached masses that have become solid on its surface. Thus, when these masses become united in a continuous sheet, a stream of still fluid lava is found arched over with a solid, continuous flooring, on which observers can safely tread.

to form the crust of the Earth.

A solid crust might thus be formed at the earth's surface, long before the process of convection extended to any great depths. We should thus ultimately have a solid shell containing within it a mass of matter still in a fused condition. That this is the most probable nature of the process which would take place, appears from other phenomena accompanying the cooling of igneous rocks. The formation of volcanic bombs presents us in miniature with something analagous to the process of solidification that occurs on a grand scale within the crust of the globe. I shall have occasion to refer to a very instructive instance of this kind, which came under the notice of Mr. Darwin, and which I have already quoted elsewhere.[5]

After the formation of the first stratum of the shell, it is probable that its extreme tenuity (compared to the Earth's radius) would subject it to continual rupture and displacements, from the forces acting upon it; but, in studying the manner in which the solidification of the mass proceeds, we shall, for the present, abstract such disturbing causes. The passage of any fluid stratum in contact with the solid shell, from its fluid condition to the

[4] Voyage dans les Deux Siciles, t. i., p. 62

[5] Phil. Mag., August, 1856.

solid state, would be accompanied by the elimination of latent heat. A portion of this heat passing downwards to the strata reduced in temperature by convection, would tend to further neutralize the effects of that process, and to render the cooling of the whole mass more gradual.

Changes in the distribution of matter within the Earth produced by the process of solidification.

If we conceive the stratum of fluid in contact with the shell, and which is on the point of passing to the solid state, to be divided into an infinite number of prisms, each having its axis pointed in the direction of a radius from the centre of the Earth, it will suffice to examine what happens to one of these prisms, in order to understand the process of solidification of the entire stratum. When the temperature of the prism has been sufficiently reduced to cause it to become solid, it will contract in volume perpendicularly to the surface of the shell, and thus tend to leave an empty space between itself and the remaining fluid, in the direction of the line joining it with the centre of the Earth. This canal of fluid will, therefore, be free from the pressure of its solidified outer stratum; and if the density of its several strata be due to the pressure they support, it follows that they will thus tend to expand outwards, so as to fill up the empty space left by the contraction of the outer stratum. This tendency to expansion will, however, be in some measure counteracted by the slow contraction of the entire fluid, from the gradual loss of its heat. The density of each stratum of the fluid, in going from its surface to its centre, will evidently vary with less rapidity than before any of it had solidified; the pressure, and consequently the density, at its centre, will constantly diminish with each successive addition to the inner surface of the shell. If a solid nucleus had been originally formed at the centre from the effect of pressure, the conditions accompanying its solidification would thus be diminishing in energy; for it is evident that but little change could take place in the temperature at that point, compared to other portions of the mass. It appears, therefore, that the transition of the fluid matter to the state of solidity at the inner surface of the shell, would take place in such a way as to cause a transport of matter from the interior of the Earth towards its surface, and such as, at the same time, to render the fluid matter enclosed within the shell more homogeneous, the more advanced the process of solidification.

Illustration from the

The observations of Mr. Darwin on one of the volcanic bombs which he had found in the Island of Ascension, afford an

interesting illustration of the foregoing remarks. He noticed several such bombs, of which he selected one as the best characteristic type of their interior structure. He exhibits a figure and description of the specimen in his *Naturalist's Voyage*, p. 493. When broken, the specimen showed that its central part was coarsely cellular, the cells decreasing in size towards the outer portion; this cellular mass was surrounded by a hard, shell-like casing, about one-third of an inch in thickness; this was again covered over with a coating of finely cellular lava. He accounts for these appearances by saying that the external crust must have cooled rapidly into the state in which it was actually observed; then the lava still fluid within was urged by the centrifugal force developed by the rotation of the bomb, as it spun around its centre while moving through the air, and thus was produced the compact, strong shell; and lastly, the centrifugal force, by relieving the pressure on the central parts of the mass, allowed the vapours there to expand their cells, thus producing the coarsely cellular structure of the interior. In this case, the energetic action of the centrifugal force caused the phenomena to be developed in a very striking manner; but it is manifest that any other force tending to expand the fluid enclosed by the external solid shell, would have more or less of the same tendency generally, namely, the removal of matter from the interior to the exterior of the cooling mass. The expansive tendency of the fluid composing the nucleus of the Earth, if greater than its contraction from the slow refrigeration of its entire mass, would also develop a series of pressures at the inner surface of the shell. The existence of such pressures seems, moreover, to be indicated by another circumstance connected with the Earth's structure, which we shall presently examine.

Appearances presented by volcanic bombs.

In my *Researches in Terrestrial Physics*,[a] I have shown that the tendency of the matter composing the nucleus to become successively more homogeneous, would modify the form of the surface of the nucleus. It would become more oblate with each successive diminution of its radius. The strata of the shell solidified from it, would therefore tend to become more oblate, and at a given period of the process of solidification of the Earth, the inner surface of

[a] Philosophical Transactions, 1851, Part II.

the shell should possess an ellipticity greater, or at least not less, than that of its outer surface.

General arrangement of the strata of the solid crust of the Earth and of the fluid nucleus contained within it.

The oblateness of the strata of equal density of the nucleus would still follow the general law of diminution, in going from the surface of the nucleus to its centre, though the rapidity of that diminution would not remain always the same, under the conditions of decreasing dimensions and decreasing density of the fluid mass. The appearance finally presented by a section made through the Earth's centre, would be somewhat like that indicated in the adjoining figure. The shaded portion represents the solid shell, and the ellipses drawn within the light portion represent the forms of the strata of equal density in the fluid nucleus.

The ellipticities of the inner and outer surfaces of the shell, are here represented as equal, while those of the surfaces of equal density in the nucleus, are represented as diminishing towards the centre.

Erroneous assumption with

Hitherto, the exterior figure of the Earth, and the arrangement of its internal strata of equal density, have been treated by mathematical investigators on the hypothesis that the particles of the fluid underwent no change

whatever in their positions on entering into the solid state. This formed the basis of the investigations of Clairault and Laplace, and seems even to have been tacitly assumed by Mr. Hopkins, in his valuable inquiries as to the influence of the Earth's internal structure on the phenomena of precession and nutation. I had, in the first part of my *Researches*, pointed out the necessity of discarding so useless and embarrassing a supposition, and in the second part was enabled to apply certain experimental results, which appear to show that the assumption is altogether inadmissible. which the hypothesis of the primitive fluidity of the Earth had been encumbered.

On this erroneous supposition, the forms of the strata of the solidified shell would, of course, correspond strictly with the figures of the strata ot equal density in the original fluid mass, before any of it had passed to the solid state. The importance of discarding this superfluous error, and of considering the fluid matter originally or actually composing a great part of the Earth as possessing similar physical properties to fused rocks, coming under our notice, becomes immediately apparent by the remarkable difference in the results as to the internal structure of the globe. This conclusion will be rendered still more apparent by comparing my results with one of the most important of those to which Mr. Hopkins has been led. He has shown that, if P_1 denotes the precessional motion of the Earth, considered as a solid, homogeneous spheroid, with the ellipticity ε_1, and P', the precession of the Earth, considered as a heterogeneous fluid nucleus enclosed in a heterogeneous solid spheroidal shell, of which the interior and exterior ellipticities are respectively ε and ε_1, we shall have the relation:— Important results regarding the internal structure of the Earth follow from discarding this erroneous assumption.

$$P' - P_1 = \left(1 - \frac{\varepsilon}{\varepsilon_1}\right) F\,(a)\,P_1$$

$F\,(a)$ being a function of a, the radius of the nucleus, and always a little less than unity. From what has been stated, it appears that ε cannot exceed ε_1, consequently P' cannot exceed P_1, a result totally different from that obtained by observation. I should add that Mr. Hopkins's result is founded upon the supposition that the transition from the perfect fluidity of the mass to the complete solidity of the shell, is not gradual but abrupt, and that no viscidity, molecular pressure, or friction exists at their surfaces of contact. It is evident that all these assump- Pressure

and friction exist between the fluid nucleus of the Earth and its solid envelope.

tions must be abandoned; and, on the contrary, I have been led to conclude that, between the shell and nucleus, pressure and friction actually exist to so great a degree as to cause the entire mass to rotate in space very nearly as one solid body.

To more clearly understand how a normal pressure may exist at the surface of contact of the nucleus and shell, let us consider what would take place if the shell solidified without any contraction taking place in the particles of the fluid on changing their condition. The density of the strata of the shell would, as already stated, be the same as that of the fluid strata which they replaced. The density of the surface stratum of the nucleus having the radius a, would be the same as that which it possessed when it was merely an internal stratum of equal pressure; it would, therefore, depend on the pressure; for if the density of any stratum of the fluid is proportional to the pressures of the outlying strata, that density must be a function of the depth below the surface. The pressure of the fluid against every unit of surface of the shell will therefore be represented by the area of that unit of surface, multiplied by the height of a column of fluid required to compress the surface of the original fluid to the density of the stratum, situated at the distance a from the centre. In this case, therefore, such a pressure, so far from being negligible, would be so enormous as apparently to render unnecessary any further inquiry as to the movements of the fluid and solid portions of the Earth. Investigators of the figure and structure of the Earth, such as Laplace, who have neglected to consider the change of physical properties of the fluid matter on entering the solid state, seem to have been conscious of the result of their omission by treating the dynamical problems of the Earth's rotation as if the nucleus and shell moved together as one solid mass. Contraction of the matter of the Earth's nucleus on its congellation from the fluid state, would diminish the pressure against the shell. If we adopt for illustration the most reasonable law of the pressure Π, and density ρ, at any stratum of the fluid

Influence of change of state of the fluid on the pressure exercised by it against the Earth's crust.

$$\frac{d\Pi}{d\rho}=2c\rho;$$

then, in the case where there is no contraction, we shall have at a unit of surface of the shell $\Pi'=c\rho_1^2+C$. When.

contraction is introduced, it will follow, as I have shown,[7] that the coefficient of contraction will continually approach to unity, in going from the surface of the Earth to its centre, during the stages of its solidification, where it will finally attain that value.

In the case of contraction, we may write for the same radius of the surface of the nucleus, $\Pi' = c\rho'^2 + C'$, in which $\rho' = K\rho_1$, K being a function of the coefficient of contraction k, of the fluid having the density ρ' when it passes to the fluid state. As $\rho' = k\rho_2$, ρ_2 being the density of the stratum of solid shell formed by its solidification; and as ρ_2 is generally greater than ρ_1, it follows that K must be greater than k, for

$$k\rho_2 = K\rho_1, \text{ or } K = k\frac{\rho_2}{\rho_1} \text{ and } \rho_1 < \rho_2, \text{ etc.}$$

The almost entire absence of conducting power in the fluid, and the impediments already adduced to show that rapid convection could not extend to any considerable distance below its surface, seem to show that the slow contraction of any column of fluid, reaching from its centre to its surface, will be much less than what would be at first supposed. There are, therefore, reasonable grounds, independently of the result deduced from Mr. Hopkins's researches, that the difference between the expansive tendency of the nucleus and its general contraction would result in a pressure at the inner surface of the shell. It is only sufficient to remember that the slow accession of matter from the nucleus to the shell, during the process of terrestrial refrigeration must result in a highly crystalline structure of the inner surface of the shell, as pointed out by Bischof and others, as well as to keep in view the dislocations that may from time to time occur, to immediately perceive that sufficient cause exists for producing such an amount of friction as would be effective, along with the pressure, in causing the shell and nucleus to rotate together nearly as one solid mass. The projection of great crystalline masses into the remaining fluid would thus, not only by increasing the tangential action between the nucleus and shell, account for the result I have adduced, but they would also give rise to a series of reactions producing disturbances in the superficial positions of the

Crystalline structure of the inner surface of the Earth's crust.

[7] Phil. Trans. 1851, Part II. p. 524.

fluid, whenever, from any cause, a tendency should exist for the nucleus and shell to move with different velocities. Such a tendency would be in constant action from the very nature of the process of solidification, whereby matter is transported from the centre of the nucleus to its surface, and from the nucleus to the shell. These reactions may thus be effective in disturbing the surface of the fluid, so as to produce sensible undulations, and thus give rise to some portions of the phenomena of earthquakes.

Connexion of the preceding views with geological dynamics. The influence of these results on such geological theories as attempt to explain the phenomena of the elevation and depression of the Earth's surface have not yet been fully developed. A great living geologist has endeavoured to account for many of these phenomena by the gradual subsiding of the solid shell upon the contracting nucleus within it. Thus, he maintains, ridges and protuberances would be produced at different epochs, so as to constitute the different chains of mountains scattered over the surface of the Earth. The structure of the central axes of the great mountain-chains of the world seems to indicate that portions of them have been often ejected from the interior in a liquid or pasty condition. Such fractures cannot always be traced in the rocky masses which form these axes as would necessarily indicate that they are merely the ridged edges of a great subsidence, and their appearance would frequently be much more easily explained by considering them as the results of the elevating forces originating in the pressures here adduced, gradually pushing forth through the broken shell certain portions of the imperfect fluid, which form the surface of the nucleus. The results to which I have been led seem to indicate that the reaction of the interior and still fluid nucleus upon the exterior crust of the Earth, takes place in such a way as might be applied to explain many of the interesting symmetrical relations of the configuration of our planet, which M. Elie de Beaumont has so ably and laboriously grouped together, in his work on the mountain systems of the globe.[8] In thus referring to M. Elie de Beaumont's researches, it will be readily understood that I am far from implying that all his conclusions are satisfactorily established. At the same time, there can scarcely be a reasonable doubt as to the existence of cer-

[8] Notice sur les Systèmes de Montagnes. Paris, 1852.

tain relations of a symmetrical character between so many widely distributed phenomena of elevation, belonging to the same or to successive geological epochs, as would indicate the operation of general and wide-spread disturbing agencies beneath the solid crust of our planet.

Foldings and ridges of the Earth's crust capable of being produced by elevatory actions.

If some parts of an elevated district were fractured, while its other parts were still entire, it is easy to perceive how foldings and ridges would be produced, as well as in the system of subsidence. This view is further confirmed, by considering that the thickness of the solid shell of the Earth, although small compared to the Earth's radius, would soon be sufficiently great to enable the shell to stand of itself, independently of the support of the fluid nucleus beneath. It is true, that if both surfaces of the shell possessed ellipticities, such as they had when the matter composing them was in a fluid state, its smallest limiting thickness, at the present day, might be an evanescent quantity; for, with any thickness, the phenomena of the variation of gravity, of the inequality in the Moon's motion, and of precession and nutation, would be precisely the same, whether the Earth was fluid to its surface, or solid to its centre; but, as it already appears that if we admit a change of position in the particles composing the fluid in their passage to the solid state, the ellipticities of the inner and outer surface of the shell will follow a different law from that of the original fluid strata of equal pressure, we cannot immediately conclude that the limiting value of the present thickness of the Earth's crust is evanescent. I have attempted to assign a limiting thickness, which is also very small, but I admit that the calculations on this point require revision, for as yet we want some of the most important data. It will not suffice to take, as is usually done, the surface of equilibrium of the watery covering of the Earth, as the Earth's true surface, for by so doing, we would be already begging the question to be decided; we would be thereby tacitly assuming that the Earth's surface is perpendicular to gravity, an assumption from which the evanescent value of the thickness of its crust would immediately follow. The elegant manner in which Professor Stokes has deduced Clairault's theorem, shows, with remarkable clearness, that if we assume for the Earth's surface the characteristic property of a fluid surface, the variation of gravity and other statical and dynamical results of the Earth's figure and structure, will be the same, whatever may be its internal

The surface of equilibrium of the watery coating of the Earth not the Earth's true surface.

constitution. But if we consider the surface of the Earth as that surface which would be exposed to view by stripping off, not only its liquid covering, but the strata of sand, clay, and rock, which had evidently been deposited from water in a sedimentary condition on the outer surface of the solidified shell, we shall have a surface differing from that of the water covering of the spheroid. The immense elevated table-lands of central Asia and of the the New World, and still further, the great depressions of the bed of the ocean, revealed by recent soundings and tidal phenomena, sufficiently prove that the water surface is far from representing with certainty the true surface of the solid spheroid; and although the former is necessarily perpendicular to gravity, so far from being entitled to infer that the latter possesses the same property, we might very safely assume the reverse.[9] We may therefore fairly infer provisionally, that the thickness of the shell is not necessarily so extremely small as to be a negligible fraction of the Earth's radius, when considering the great statical and dynamical conditions of the Earth.

Inconclusiveness of Mr. Hopkins's estimate of the thickness of the Earth's crust.

The results obtained by Mr. Hopkins regarding the minimum thickness of the Earth's crust, which would be consistent with the observed amount of precession and nutation, having been sometimes referred to by geologists, it is right to add that these results are not at all conclusive. They are derived from a discussion of the values of the fraction $\frac{\varepsilon}{\varepsilon_1}$ contained in the expression already quoted. In order to estimate the value of this fraction, Mr. Hopkins tacitly assumes that the forms of the strata of equal density in the solid crust, including that of its inner and outer surfaces, are precisely the same as those of the fluid mass from which the strata had solidified; and in short, that the process of solidification of the globe was accompanied by no change whatever in the geometrical distribution of its particles. This assumption can now no longer be considered as tenable, consequently no conclusions as to the thickness of the Earth's crust can be derived from considerations of which it forms the essential foundation.

Difficulty of accounting for

With any but a very small thickness, it appears impossible that subsidence of the shell could take place in such a way as to account for the phenomena of elevation

[9] These views have been further developed by the author in a paper read at the meeting of the British Association in Dublin.

of mountains or plateaus on their edges. If any portion of the crust were unsupported by the nucleus, its tendency would be to support itself on the principle of the arch. We cannot compare its condition to that of a thin, unsupported, and brittle egg-shell, as has been done by M. Elie de Beaumont, for the attractions to which the solid shell of the Earth is subjected, acting very nearly perpendicularly to the tangent plane at any point of its inner surface, acts precisely in the direction best adapted for securing its stability. On the contrary, a small, round object like an egg-shell, at the Earth's surface, is subjected to parallel pressures, and is thus placed under more unfavourable conditions for stability. the production of mountains, by subsidence of portions of the Earth's crust.

If we consider two arches of equal dimensions and strength, one with a mass of fluid pressing down on its extrados, the other with a mass of fluid pressing upwards on its intrados, the head of fluid producing pressure in both cases being equal to the depth of the fluid over the first arch, it is manifest that the second arch would be far more readily burst upwards than the other would be crushed downwards. It is well known to engineers that arches made to sustain incredible pressures from above, may be easily "blown up" by a comparatively moderate pressure from below. Illustration from the equilibrium of arches.

The forces resulting from the expansion of the nucleus, and its pressure against the shell, are, as well as the action of gravitation, perpendicular to the tangent planes of the shell, but while the latter acts in the direction most favourable to stability, the former act in the direction most favourable to rupture, and would, therefore, be far more likely to be effective in producing disturbances of the Earth's crust, and above all the elevation of the lines of mountains, which impart such a peculiar character to its general configuration. In my *Researches on Terrestrial Physics*, I have in some measure considered the action of such a pressure, combined with another that would result from a tendency in the nucleus to change its figure, and I have shown that if the former happened to be small compared to the latter, a zone of least disturbance might exist on the Earth's surface, for the position of the boundaries of which formulæ are assigned. As no trace seems to exist of such a zone from geodesical measurements, I was led to infer that the general pressure predominated over the variable pressure, and, therefore, that lines of elevation on the Earth's surface The pressures exerted by the fluid nucleus of the Earth against the solid crust, present adequate causes for phenomena of elevation.

should not present any marked relation of parallellism, either to the equator or to the meridians. It is satisfactory to find that this theoretical inference is confirmed by a conclusion of M. Elie de Beaumont, in the work already quoted. If the lines of elevation of the Earth's surface are grouped, so as to form, for the most part, a series of diametral lines to each figure of a network of regular pentagons, I cannot see any reason why such a symmetrical network might not be formed far more readily by the pressure of the nucleus acting outwardly against the shell, than by the subsidence of the latter inwards. The more regular and symmetrical the arrangements of the mountain systems, the more difficult it appears to reconcile them with mere subsidence, and the more easily do these arrangements seem to admit of explanation by the action of purely elevatory forces. The analogy between an interior, expanding, elevatory force, which separates the parts of a mass, and the molecular forces, which cause portions of certain rocks—for instance, basalt—to split into polygonal prisms, is far more clearly manifest, than between these phenomena and the crushing force which would accompany an action of subsidence. Lines of least resistance to separation or simple fracture, are more easily determined by the action of these forces, than lines of easiest crushing or squeezing, and greater symmetry might be fairly expected in the distribution of the former than in that of the latter.

Art. III.—*Note on the differences of level (seiches) observed by M. Stabrowski on Lake Onéga in Russia.* By Henry Hennessy.

THE phenomena briefly described by M. Stabrowski in the *Comptes rendus* of the French Academy for last July, present some relations of resemblance to those occurring on the surface of Lough Erne, the physical explanation of which is contained in a letter addressed by me to the President of the Royal Irish Academy, which appears in the Proceedings of that body.[1]

Both at Lough Erne and Lake Onéga, the abnormal

[1] Vol. vi, p. 279.

condition of the surface of the water is due to atmospheric disturbance; but while in the former the action of the air seems to be entirely dynamical, in the latter its mode of action, and the resulting effects, present a statical character. The transitory wave of translation, which sometimes unexpectedly beats against one of the shores of our Irish lake, is due, as I have shown, to the action of descending currents of air from the hills at the opposite side; but Lake Onéga appears to act under changes of atmospheric pressure, like a differential barometer. It possesses all the conditions essential for this purpose, being long and narrow. The result is, that accidental differences of atmospheric pressure at its extremities would produce very observable changes in the water level. The rising of the water at one side of the lake is usually accompanied by a fall in the barometer, and *vice versa*. The *seiche* is always the precursor of wind [horizontal currents], and the oscillations of the surface of the lake enable the natives to foretell the direction and force of the winds.

Art. IV.—*On the formation of several Acids of the series $C_nH_nO_4$, by the Destructive Distillation of Peat.*[1] *By* William K. Sullivan. *Being Part* I. *of the Chemical History of the Products of the Destructive Distillation of Peat.*

Action of heat upon animal and vegetable substances in close vessels.

WHENEVER we submit animal or vegetable substances to the action of heat in close vessels, we obtain three classes of products—gaseous, liquid, and solid. The gaseous products consist chiefly of carbonic acid, carbonic oxide, olefiant gas, and marsh gas. The liquid products consist of water holding certain liquid and some few solid bodies in solution. Another portion of the liquid products insoluble in water, and holding the chief part of the solid bodies in solution, forms a mass

[1] An abstract of the chief results contained in this paper was read at the Dublin meeting of the British Association, August 27, 1857.

of a more or less oily or butyraceous consistence, known as tar. The bodies held in solution by the water and the constituents of the tar are very numerous and various. But their relative proportions, and in some respects their nature also, depend upon the kind of body submitted to distillation, and upon the temperature at which the distillation takes place. The latter circumstance, indeed, not only affects the constituents of the tar and the bodies held in solution in the water, but also the gaseous products. If the distillation be effected at a very low temperature, scarcely any or no gas will be produced; if at a very high temperature, abundance of gas, and scarcely any liquid or solid products, will be formed.

Classes of bodies produced.

The liquid and solid products may be classified under four heads: 1. bases; 2. acids; 3. alcohols, ethers, and similar compounds; and 4. carbo-hydrogens. Bases are the result of the decomposition of azotic bodies, and their amount and number will therefore depend upon the quantity of nitrogen in the substances operated upon. Animal bodies, such as bones, blood, etc., will accordingly yield more than vegetable substances. The precise conditions upon which the formation of acids depends are not well understood; but it is evident that the substances which yield them must contain oxygen, if we except one, hydrocyanic acid, which contains nitrogen, and is accordingly formed most abundantly in the distillation of animal substances. The third class of bodies appear to be most readily formed from woody and amylaceous substances. The fourth are formed from all indifferently, though doubtless different kinds are produced from each substance distilled.

Effects of the variation of temperature of distillation.

Generally speaking, it would appear that the effect of increasing the temperature of distillation is to lower the atomic weight of the bodies produced. Thus, for example, at comparatively very high temperatures the bases consist almost entirely of ammonia; at still higher temperatures, even this will be in part converted into cyanogen or totally decomposed. At comparatively low temperatures, several of the compound ammonias will also be produced, such as methylamine, ethylamine, aniline, etc. Similarly, among the hydrocarbons resulting from distillation at a low temperature, we have a large proportion of solid bodies, and a large proportion of the liquid ones have very high boiling points. The hydrocarbons produced at a high temperature, on the other hand, are

chiefly liquid; and we may even carry the temperature high enough to get them in great part as gases or liquids with extremely low boiling points, or even to decompose them altogether, and get as our chief volatile product marsh gas.

We know as yet too little about the circumstances affecting the production of the second and third classes of products, to speak positively upon the effect of temperature upon them; but there can be no doubt that it is similar to that exerted upon the bases and carbohydrogens.

Substances whose products of distillation have been studied. The substances whose products of distillation have been hitherto studied, are wood, coal, bituminous shale, and bones. The first yields the largest proportion of bodies belonging to class 3; the latter appears to give the largest proportion of bases. The products of another substance, peat, can now be added. This substance stands intermediate between wood and coal, partaking of the character of the one or of the other, according as we operate upon the light moor peat, in which the vegetable structure of the plants from which it was formed is still visible, or upon the compact earthy peats, in which all trace of organized structure has disappeared. The products are probably more numerous and various than even those of wood, the more so because the temperature of distillation of peat is perhaps lower than that at which the distillation of any other bodies distilled on a manufacturing scale is effected.

Connection of present researches with a former technological investigation. Mr. Rees Reece proposed, about seven or eight years ago, to effect the distillation of peat in a novel manner, with the view of obtaining certain of the products for commercial purposes. This process was made the subject of an investigation, in which I was engaged, while chemist to the Museum of Irish Industry, in the year 1850, and although of an altogether technological character, it afforded me during its progress an opportunity of seeing that the complete investigation of the products from a scientific point of view would be extremely interesting and important. Among the observations which I then made were, the detection of butyric acid, cyanide of ammonium, and cyanide of methyl, or acetonitrile C_4H_3N, among the products of distillation, and the probability of the presence of other hydrocyanic ethers or nitriles. These observations were not mentioned in the report of the investigation published as a par-

liamentary document in 1851, for several reasons, but chiefly because the analytical proofs being defective, I preferred omitting all mention of them until I could enter upon a thorough investigation of the whole of the products, after the technological part of the subject had been completed. Want of time and other causes prevented me, however, from resuming the subject until the present year. In the meantime the process of distillation has been carried out commercially, and I have thus been enabled to obtain sufficient quantities of the raw products to pursue the investigation with far greater chances of obtaining successful results, than I could have hoped for otherwise. Indeed, it would be perfectly impossible to investigate the subject at all, but for the facility of operating upon large quantities of materials.

In this and following memoirs on peat products, the acids, alcohols, and ethers will be first treated of.

As very little attention has hitherto been bestowed on the acids produced by destructive distillation, or their allied bodies, the alcohols and ethers produced by the same process, I purpose taking up this branch of the subject first, leaving the investigation of the bases and carbohydrogens to a later period. In this first instalment I shall confine myself chiefly to the results obtained with respect to that most remarkable and important class of acids having the formula $C_nH_nO_4$.

In order to understand the exact mode of occurrence of the several bodies to be described in this and succeeding memoirs, it will be necessary to briefly describe the process by which the peat is distilled on the great scale.

Description of process of distillation of peat.

The retorts employed for the distillation of the peat are unlike those used in any other process of distillation, being no other than ordinary High Furnaces, similar to those employed in iron smelting, and, like them, supplied with a blast of air, blown through three tuyeres by a cylinder blowing machine. Each furnace is capable of holding from fifteen to twenty-five tons of peat, according to its density, and is completely covered down, having a peculiarly-contrived hopper for feeding the furnace, and two outlet-pipes for conveying away the products of distillation and combustion into a main somewhat similar to that used in gas works, but somewhat differently disposed. Connected with this main is a peculiar refrigerator or condenser, consisting of a series of isolated chambers divided by diaphragms and connected by a series of upright pipes, and then a series of scrubbers, consisting of cylinders with several gratings, upon which rest suc-

cessive layers of round pebbles, and through which water can be made to fall as a dense rain.

The furnaces being filled with peat and ignited, the blast is turned on, and the distillation proceeds. But there is combustion going on also; that is, the charcoal produced by the distillation is completely consumed by the blast of air blown in at the tuyeres. At this point an intense heat is produced, and the whole of the oxygen of the air is converted into oxide of carbon. This compound, together with the unaltered nitrogen of the air, both at a very high temperature, then pass up through the mass of turf in the furnace and char it, the products being carried forward by the blast through the outlet-pipes into the main, where the liquid and solid products are partly condensed; thence the current of gaseous matter passes through the condensers and scrubbers, where the remainder of the solid and liquid bodies are deposited. **Distilling furnaces.**

It must be already apparent that no charcoal is obtained in this process, the whole of it being consumed in the bottom of the furnace, in order to supply heat to distil the fresh peat added from time to time through the hopper at top.

Notwithstanding that the distillation takes place in a blast of air, the process, so far as the products of distillation are concerned, does not differ in results from close distillation in ordinary retorts. The operation, too, is carried on at a very moderate temperature; for although that of the gases, as they ascend from the hearth where the combustion of the charcoal takes place, is extremely high, yet they become so rapidly cooled by the latent heat absorbed by the large quantity of water which must be evaporated from the turf (that generally used giving about 35 to 40, and sometimes even 50, per cent. of water by distillation), that the temperature at the top of the furnace scarcely ever exceeds 200° Cent., and in the outlet-pipes it rarely exceeds 110° Cent. The fresh turf is, in fact, partially distilled by a current of hot steam and gases in the upper part of the furnace; the complete charring being effected lower down by the hot gases alone. **Temperature of distillation.**

If the volume and force of the blast be sufficiently increased, a bright red heat may be obtained in the upper part of the furnace, and even the outlet-pipes may become red-hot; but in practice the blast is so regulated that the temperature above stated is not exceeded Indeed the lower the temperature at which the process can be carried

on, the greater will be the amount of those products which are of commercial importance. The process would be most perfect if no gaseous carbo-hydrogens were produced, that is, if all the hydrogen came over in the form of liquid and solid compounds.

Distribution of the products in the condensing apparatus.

A considerable part of the tar is deposited in the main, and a great part of the water also, the remainder of both is deposited in the condensers and scrubbers. From the latter the gaseous products, consisting of nitrogen, oxide of carbon, carbonic acid, marsh gas, a small portion of olefiant gas, and the vapours of some of the more volatile carbo-hydrogens, pass under the different boilers and stills, where they serve as fuel for the production of steam, etc. The water which collects in the main contains less of the volatile, liquid, or solid products in solution than that which is condensed at the end of the condensers and in the scrubbers, where the chief part of the methylic alcohol, ethers, etc., is condensed. The tar collected in the main is also more solid than that which is collected in the scrubbers, which is often semi-fluid or about the consistence of wood-tar.

Distillation of tar.

The tar deposited in the main and in the condensers is collected and subjected to distillation in a current of super-heated steam. The product which comes over consists chiefly of a number of liquid carbo-hydrogens of different boiling points, holding in solution a number of solid ones, that in greatest quantity being paraffine. There are also present a great number of other substances (bases, carbolic acid, etc.), but in comparatively small quantity. As the history of these products will form the subject of another paper, I will not further allude to them here.

The quantity of water which distils over from turf is enormous, and consequently we may expect to find a large proportion of the solid and liquid products, which are soluble in water, in solution in it. The more abundant of these are ammonia, in combination chiefly with acetic acid and methylic alcohol. The ammonia and alcohol are capable of being separated in a state of more or less purity, and are consequently of commercial importance; but the acetic acid cannot be economically prepared, and is not consequently separated. The process of separating the methylic alcohol and ammonia consists in agitating the aqueous liquid with caustic lime, which combines with the acid bodies and sets the ammonia free. The liquid, after the undissolved lime and the

Separation of ammonia and wood-spirit.

resinous bodies, which form insoluble compounds with lime, have settled to the bottom, is distilled in a Coffey's still. The products of this operation are—1. an impure liquid, containing wood spirit and free ammonia, and a great number of other bodies, but in smaller quantity (bases, carbolic acid, acetic ether, nitriles, etc.); and 2. an impure brown liquid, containing the lime salts of the acids, which is allowed to run waste. The impure mixture of methylic alcohol and ammonia is treated with sulphuric acid sufficient to neutralize the ammonia, and again distilled. The sulphate of ammonia and other bases remain behind in the still, and are run off and evaporated in leaden pans to crystallize the sulphate of ammonia. The distillate contains the methylic alcohol and other neutral bodies.

Treatment of liquor containing acids.

Leaving the history of the bases accompanying the ammonia, and the bodies mixed with the methylic alcohol, as subjects for other subsequent papers, I will return to the waste liquor containing the lime salts. This liquor is so very dilute, that an immense volume must be evaporated in order to obtain sufficient of the mixed lime salts to be able to effectually separate the acids. Several hundred gallons were accordingly evaporated in a leaden pan, so as to reduce the whole to a small bulk. During the operation, a large quantity of pitchy or tarry matter separated, and was removed. The concentrated liquor was still further evaporated in the laboratory, generally until a pellicle formed on the surface. Sulphuric acid, diluted with twice its weight of water, was then added in sufficient quantity to decompose the lime salts; the whole was allowed to stand until the tarry matter, sulphate of lime, etc., had settled to the bottom, when the clear liquor was distilled.

The acid liquor which came over was usually somewhat milky, when the solution of lime salts had been evaporated to a pellicle before decomposition with sulphuric acid, otherwise it was clear and of a straw yellow or pale brown colour. When left exposed to the air for a few days, this colour changed to a dark reddish brown. The acid always smelled like a combination of the smell of vinegar with that of rancid butter, more or less masked, however, by the strong and disagreeable smell which pervades all peat products.

This acid liquor was neutralized with carbonate of soda, and concentrated by evaporation, and set aside until

a good crop of crystals of acetate of soda was obtained. These were removed and left to drain in funnels for some days; the drainings were added to the mother liquor, and the whole again concentrated by evaporation, and set aside to crystallize in a warm place for some days, during which a further crop of crystals of acetate of soda separated. The mother liquor drained from these crystals yielded a white precipitate with acetate of zinc, insoluble in water and alcohol, but readily soluble in cyanide of potassium. Treated with strong sulphuric acid and distilled, an acid liquor came over, having the characteristic odour of hydrocyanic acid. Some of this liquor, treated with a few drops of potash and then with a few drops of protosulphate of iron, containing a little persulphate, and heated, and then treated with a few drops of hydrochloric acid to dissolve the precipitated oxide of iron, yielded Prussian blue.[2]

Cyanogen formed during the distillation of peat.

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[2] Cyanide of ammonium appears to be always formed in the distillation of peat. But the quantity seems to be subject to considerable variation, being apparently greatest with dense dry turf distilled at a high temperature, and least with light wet turf distilled at a low temperature. According to M. Langlois (*Annal. de Chim. et de Phys., t.* lxxvi., *p.* 111), cyanide of ammonium is formed when dry ammoniacal gas passes over dry charcoal at a red heat, hydrogen being eliminated; but according to M. Kuhlmann (*Annal. der Chem. und Pharm., Bd.* xxxviii., *s.* 62), marsh gas is evolved in this reaction. Gerhardt (*Traité de Chimié Organique, t.* i., *p.* 305) gives the following equation, expressive of the change, in accordance with the results of Kuhlmann:

$$3\,C_2 + 4\,NH_3 = 2\,[C_2\,(NH_4)\,N] + C_2H_4.$$

Gerhardt also states, that if a mixture of oxide of carbon and ammonia be passed through a red-hot tube, cyanide of ammonium will be formed, thus:

$$2\,CO + 2\,NH_3 = C_2\,(NH_4)\,N + 2\,HO.$$

As the conditions required for the formation of cyanide of ammonium by either of these processes, but especially by that last mentioned, coexist in the interior of the furnace in which peat is distilled, we need not be surprised at its presence among the products of the distillation, or of the existence of several nitriles, or hydrocyanic ethers, among them also. The higher the temperature, too, within certain limits, the more favourable the conditions for the mutual decomposition of oxide of carbon and ammonia, a circumstance quite in accordance with the observation made above, that the quantity of cyanide appeared to increase with the temperature of distillation. In connection with this subject, I may mention some observations which seem to indicate that the action of oxide of carbon, at a high temperature, upon ammonia, is one of the chief sources of the formation of cyanide of ammonium in the distillation of peat. When turf containing about thirty per cent. of hygro-

Treatment of mother liquor after separation of cyanide of zinc.

The mother liquor, from which the cyanide of zinc was separated, was still further concentrated, introduced into a stoppered flask, and double its volume of dilute sulphuric acid (composed of one part of oil of vitriol by weight, and two of water) added, and the whole allowed to stand during the night in a mixture of salt and pounded ice. On the following morning nearly the whole of the sulphate of soda had crystallized out. The mother liquor was covered with a layer of an impure brown oil; this was removed with a pipette, and the mother liquor poured off. The latter was then partially saturated with carbonate of soda, as recommended by Liebig, in the process proposed by him for the separation of butyric and valeric acids by fractional distillation,[3] and distilled; the whole of the acetic acid remained behind, in the first trial with a small portion of one or more of the other acids; these small portions it was not thought worth while to attempt to separate farther. The distillate yielded a little more oil, which was added to the first quantity, and an extremely acid liquor, in which the smell of formic acid predominated. This liquor was somewhat diluted with water, divided into two portions, one of which was introduced into a stoppered flask containing freshly prepared hydrated oxide of copper, with which it was allowed to digest for some time. The remainder of the acid was then added in successive portions, the whole being well shaken, so as to take up any basic salts formed, and nearly, but not completely, neutralize the whole of the acid added. The solution was then filtered, to separate

Preparation of copper salts with aqueous product of fractional distillation.

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metric water is distilled in a closed iron retort, heated by gas or other fuel, the liquid which came over at the first period of distillation shows no trace of hydrocyanic acid, even when heated with sulphide of ammonium, and tested with sesquichloride of iron. Very little ammonia is formed in the early stages of distillation, and the liquor has even an acid reaction. When the mass approaches a dull red heat, ammonia begins to come over; and at a still higher heat, cyanide of ammonium may be detected, the gaseous mixture at the same time containing a good deal of oxide of carbon. As there is always abundance of oxide of carbon in every part of the furnace during the distillation of peat in a blast of air, the conditions are certainly more favourable for the production of cyanide of ammonium in this process, than when the distillation is conducted in closed vessels. Perhaps the cyanogen observed by Bunsen and Playfair, as a constituent of the gases of high furnaces in which iron is smelted with coal, is in part formed under similar conditions. Another source of cyanide of ammonium may also be mentioned, namely, the decomposition of methylamine and other compound ammonias, at a red heat.

[3] Annal. der Chem. u. Pharm., Bd. lxi., S. 355.

undissolved oxide and difficultly soluble copper salts of acids suspected to be present, and exposed to spontaneous evaporation in a warm place; a crystalline mass was left, which was crushed up and treated with alcohol; the undissolved residue was dissolved in water, and again crystallized by spontaneous evaporation. The salt obtained, crystallized in oblique, rhomboidal prisms, of a clear blue, and yielded, by distillation with phosphoric acid, an acid liquor having all the properties of formic acid.

Reactions of acid prepared from copper salt insoluble in alcohol, showed it to have been formic acid.

A small portion of it neutralized with soda, evaporated to dryness, and treated with some hydrate of baryta, left a residue containing oxalic acid, a reaction more or less characteristic of formic acid.[4] Another portion of the acid was treated with oil of vitriol, which decomposed it with evolution of oxide of carbon. Some drops of it, warmed with a solution of corrosive sublimate, threw down calomel, and on boiling the mixture for some time, metallic mercury was separated. The free acid did not give a precipitate with nitrate of silver; but a few drops, nearly neutralized with soda, crystallized on a watch glass, and dissolved in a very small quantity of water, so as to form a somewhat concentrated solution, yielded, with nitrate of silver, a white, difficultly soluble, crystalline precipitate, which soon darkened. On heating the mixture, the whole of the silver was reduced, and the fluid became black, from the finely divided silver in suspension. These different reactions showed that the substance was formic acid. In order to control these results by the determination of the atomic weight, the remainder of the acid was neutralized with carbonate of baryta, the solution filtered, and the filtered liquor set aside to crystallize. The crystals formed were drained, washed with distilled water, dissolved in water, and again crystallized over sulphuric acid. The crystals formed did not lose their transparency when exposed to the air.

Corroborated by determination of atomic weight.

0.715 grammes of the baryta salt dissolved in water, and precipitated by dilute sulphuric acid, gave 0.730 grammes of sulphate of baryta, =0.479 grammes of baryta, which corresponds to the following composition in 100 parts:—

	Calculated.	Found.
C_2HO_3,	32.550	32.906
BaO,	67.450	67.094

[4] Peligot Annal. de Chim. et de Phys, lxxiii. 220.

The numbers found agree sufficiently well with the theoretical ones, considering the great difficulty of separating and purifying mixed acids of this kind, where the quantity of material to be operated upon is small; and in this case there was the additional difficulty of the presence in the crude acid of a great quantity of tarry matters, in the separation of which a good deal of material was lost.

The oil was next examined. It was agitated with chloride of calcium, to remove adhering water, and then distilled. The portion which passed over at temperatures under 140°, was collected apart; the operation was continued until the temperature rose to 160°, when the residue became quite thick and tarry, and nothing further could be done with it, as the quantity was too small to attempt the further separation of its constituents by other means. Having since obtained a much more considerable quantity of material, I hope to be able to separate the substances of a higher boiling point than 160°. Examination of oil.

The oil which came over at temperatures under 140° was partially neutralized with carbonate of soda, and distilled. The distillate consisted of an oily liquor, having a piercing, disagreeable smell, reminding one at the same time of rancid cheese and the smell produced in the boiling of soap. This oil was again distilled with a very small quantity of carbonate of soda, the temperature being carefully regulated by means of a fusible alloy bath. The distillate was a clear, oily liquid, which boiled at 140°, and distilled without change. It dissolved in water, the excess of oil floating upon the surface of the saturated solution. Carbonate of potash was added to this solution to neutralize it, and the whole evaporated to dryness. The dried mass was treated with anhydrous alcohol, which dissolved the potash salt, leaving the excess of carbonate of potash behind. The alcoholic solution of the potash salt was then treated with ether, which precipitated the potash salt in colourless Oil boiling at 140° C.

[a] Among the many sources from which the formic acid present in the peat liquor may be derived, we may mention the hydrocyanic acid. It is well known that if we boil a solution of cyanide of potassium, we convert it into ammonia and formiate of potash. Even a solution of it in stoppered bottles gradually decomposes, carbonate and formiate being formed. During the boiling of the liquor containing the lime salts, the cyanide of lime must be also partially decomposed. This, though it must certainly be one of the sources of the formic acid, is not the only one.

Analysis of potash salt.

pearly scales, feeling fatty to the touch. This salt was employed to determine the composition of the acid.

0.650 grammes of this salt, dried at 130° and burned with oxide of copper, gave[6]

0.755 grammes of CO_2 (inclusive of that combined with the potash, which was supposed to remain behind as carbonate), and 0.262 grammes of HO.

0.345 grammes of the salt, dried at 130°, gave by treatment with SO_3HO, evaporation to dryness and ignition: 0.268 grammes of sulphate of potash = 0.145 grammes of potash.

These numbers lead to the following formula and composition in 100 parts:—

	Calculated.	Found.
C_6	32.085	31.678
H_5	4.456	4.478
O_3	21.392	21.816
KO	42.067	42.028
	100.000	100.000

Determination of atomic weight with baryta salt.

These numbers were further controlled by the determination of the atomic weight from the analysis of the silver salt. This salt was prepared by precipitating a solution of the potash salt with nitrate of silver: a white apparently crystalline precipitate was formed, which slightly blackened, and then partially decomposed on boiling the mixture for a few minutes. On cooling, the salt was deposited in warty grains, which, on examination with a lens, appeared to be composed of a peculiar arrangement of needles. By careful recrystallization from a dilute solution left to spontaneous evaporation for a few days, the salt was obtained in colourless needles.

0.415 of this salt, dried over sulphuric acid, gave 0.247 of metallic silver = 0.265 of oxide of silver, or in 100 parts,

	Calculated.	Found.
$C_6H_5O_3$,	35.912	36.074
AgO,	64.088	63.926
	100.000	100.000

[6] In burning substances of this kind, and indeed all volatile bodies, or such as at a high temperature yield products of distillation which are

The formula resulting from this analysis is that of propionic or metacetonic acid $C_6H_5O_3,HO$. Pro-pionic acid.

Some years ago Nöllner obtained an acid from the fermented mother liquor of tartrate of lime, which he termed pseudo-acetic acid. Nicklès analyzed the body and deduced the formula $C_6H_6O_4 = C_6H_5O_3$, HO, which is the formula of the acid obtained by Gottlieb by the action of potash or dilute sulphuric acid upon hydrocyanic ether or cyanide of ethyl (propionitrile), and which can also be obtained in several other chemical reactions. Nicklès, however, believed it to differ from the metacetonic acid. Dumas, Malaguti, and Leblanc,[7] considered the acid of Nöllner to be identical with metacetonic acid; both acids, besides possessing the same composition, are also identical in smell, boiling points, and in the appearance and properties of a great number of their salts, especially the baryta salt. The subject has been again examined recently by Limpricht and von Uslar,[8] who have come to the conclusion that the acid of Nöllner is really different

Nöllner's pseudo-acetic acid,

not identical with metacetonic or propionic acid.

liable to be carried forward into the chloride of calcium tube without being fully decomposed, I have found it advantageous to use a slight modification of the usual process. The tube is of considerable length. Some oxide of copper is moistened with nitric acid, and heated very strongly in a crucible, so as to get it into a hard, sintered mass, which, when powdered, has the advantage of not being so hygroscopic as the oxide of copper usually employed. This powdered mass is again heated, and when sufficiently cooled, the substance to be analyzed is mixed up coarsely with a little of it, and introduced into the tube, previously well dried. The whole is then covered with soft oxide, heated to 200° or 250°, and filled in out of the crucible itself in which it was heated, as recommended by Gerhardt, and the tube being corked, it is tapped, so as to shake the whole together. About four or five inches of the tube in front of the mixture is then filled up with small lumps of the sintered oxide previously heated to 200°, and put into the tube hot. The remainder of the tube, for about six inches, is then filled with copper turnings, whose surface has been oxydized by being exposed at a red heat to a current of dry oxygen gas. The combustion is proceeded with in the usual way, except that the part of the tube filled with copper turnings, and part of that filled with the lumps of sintered oxide, is first heated red-hot before the combustion commences, and is kept at that temperature to the end of the operation. In this way, any carbo-hydrogens which may be carried forward by the current of carbonic acid and vapour of water, must pass through a kind of sponge of oxide of copper, and over a very extended surface of oxydized copper at a red heat, and are completely burned. When the combustion is finished, the last traces of carbon may be burned away by passing a current of oxygen gas through the tube in the way described by Gerhardt, and which was first suggested by Laurent (Gerhardt's *Traité de Chimie*, t. i., p. 85). Generally speaking, this need not be employed, except in the case of very difficultly combustible bodies.

[7] Compt. rend., xxv. 781.

[8] Annal. der Chem. u. Pharm., Bd. xciv., S. 321 (1855).

from metacetonic acid obtained from cyanide of ethyl, etc.; one of the points of difference being that the propionate of potash is separated from its alcoholic solution in a crystalline state on the addition of ether, while the butyro-acetate is uncrystallizable. The acid obtained from the peat liquor corresponds, therefore, with true propionic acid, in the circumstance of its potash salt being precipitated as pearly scales from its alcoholic solution by ether.

Difference which they exhibit in their reactions.

By repeated distillations the butyroacetic acid may be resolved into butyric and acetic acids; but propionic acid, on the other hand, may be repeatedly distilled without its boiling point changing. If propionate of potash or soda be distilled with alcohol and sulphuric acid, and water be added to the distillate propionate of ethyle, a liquid lighter than water, and having a sort of fruit, or rather fermented fruit odour, separates. This liquid may be distilled without decomposition, its boiling point remaining constant at 101°. Butyroacetic acid, on the other hand, yields, under the same circumstances, a mixture of acetic and butyric ethers, which may be separated by fractional distillation, the former boiling at 74°, and the latter at 119°. A portion of the propionate of potash obtained from peat liquor, distilled with sulphuric acid and alcohol, yielded an ether boiling at 101°, and capable of distilling unchanged, and corresponding in every respect with propionic ether.[9]

Treatment of oil boiling between 140° and 160° C.

The portion of the oil which came over at temperatures between 140° and 160° was about three-fourths neutralized with carbonate of soda and distilled; the distillate was rejected. The residue in the retort was then distilled with sufficient hydrated phosphoric acid to decompose it; the distillate was agitated with chloride of calcium, and then about one-third neutralized with carbonate of soda, and again distilled. The distillate consisted of an oily liquid, having a faint yellow tint, but becoming darker on keeping. This is also the case with nearly every peat product, no matter what pains may be taken to purify it, probably from the presence of minute traces of some body which oxidizes rapidly and blackens. The oil was neutralized by baryta water, and evaporated to dryness at a very gentle heat, a few bubbles of carbonic

[9] See a short paper, "Observations on some of the products of the putrefaction of animal and vegetable substances", at page 202 of this number.

acid being passed through the solution in the first instance, to convert excess of baryta into carbonate. The dried residue was dissolved in water, carefully filtered, and the solution set aside for some weeks during summer in a cellar. The greater part of the salt crystallized out in the form of lustrous flattened prisms, which were unaltered by exposure to the air, and melted at a temperature a little below 100° into a clear glass. Heated to 130°, they lost 18.64 per cent., which corresponds very nearly to 4 equivalents of water.

Analysis of baryta salts.

I. 0.645 grammes of this salt, dried at 130°, and burned with chromate of lead, gave 0.730 grammes of carbonic acid, and 0.264 grammes of water.

0.330 grammes of the same salt, dried at the same temperature, gave 0.247 grammes of sulphate of baryta = 0.162 grammes of baryta.

II. 0.450 grammes, burned with oxide of copper, the salt having been first mixed up with phosphate of copper, gave 0.512 grammes of carbonic acid and 0.183 grammes of water.[10]

These numbers correspond to the following per-centage composition:—

	Calculated.	Found. I.	Found. II.
C_8	30.834	30.866	31.030
H_7	4.496	4.547	4.518
O_3	15.418	15.497	15.362
BaO	49.252	49.090	49.090
	100.000	100.000	100.000

Determination of atomic weight by silver salt.

These results were controlled by a determination of the atomic weight from the analysis of the silver salt. A dilute solution of the baryta salt was treated with nitrate of silver, and exposed to spontaneous evaporation. After

[10] It is well known that in the combustion of the baryta salts of several of the organic acids by means of oxide of copper, the baryta remains behind in the tube as carbonate, while in the case of the salts of several other acids, the whole of it does not remain as carbonate. This is the case with the acids of the series now under discussion. Lerch, in his investigation on the volatile acids of butter (*Annal. der Chem. u. Pharm.*, *Bd.* xlix., *p.* 216), accordingly proposed to mix the salt to be analyzed, before mixing it with oxide of copper, with from three to four times its volume of ignited phosphate of copper. He found that the whole of the carbonic acid was driven off from the baryta, when baryta salts were burned under such circumstances.

some time pearly lustrous scales were formed, which were almost insoluble in cold water. They were well washed, and dissolved in boiling water. On cooling, the salt crystallized out.

0.365 grammes of the salt, dried over sulphuric acid and ignited, left 0.201 grammes of metallic silver = 0.216 grammes of oxide of silver. These results lead to the following numbers:—

	Calculated.	Found.
$C_8H_7O_3$,	40.513	40.853
AgO,	59.487	59.147
	100.000	100.000

Butyric acid.

These numbers represent the formula $C_8H_7O_3,HO$, which is that of butyric acid.

Constitution of butyrate of baryta.

The salt of baryta with four equivalents of water, which I obtained, corresponded with one of the salts described by Chancel, and which appears to have been also obtained by Pelouze and Gelis. Chancel stated that butyrate of baryta crystallizes either with two or four equivalents of water of crystallization, according as it is obtained from hot or cold solutions. When it crystallizes in the cold, it forms long flattened prisms perfectly transparent and containing 18.8 per cent. of water, or four equivalents. These crystals melt to a transparent liquid without losing weight when heated to a temperature below 100°. Crystallized from warm solutions, the salt contains 10.5 per cent. of water, or 2 equivalents, and does not melt at 100°. I had not enough of material to succeed in the preparation of the salt with two equivalents of water, having only obtained anhydrous crusts in every attempt which I made.

According to Lerch, butyrate of baryta appears in two different crystalline conditions, and in each is anhydrous; the one consists, as Chevreul has described, of mother-of-pearl-like plates and flattened flexible prisms; the other of hard granular crusts. The latter may, however, be converted into the former by repeated recrystallization. In either condition it did not melt at 100°. Lerch further states that he could not obtain butyrate of baryta other than in an anhydrous form.

It is difficult to account for the different results obtained by Chancel and myself, and by Lerch. The same difficulty occurs in the case of propionate of baryta, if the salt of Keller, with nine equivalents of water, be

really a propionate, for all other statements agree in considering that salt as anhydrous. I have instituted some experiments with the view of discovering the cause of the anomaly in the baryta salts of both acids, as well as to determine more exactly the constitution of the butyrates and of the double salts which they form with the acetates, but the investigation is not yet sufficiently advanced to enable me to give any results here.

Acids of the series $C_nH_nO_4$, whose presence has been established.

The acids of the series $C_nH_nO_4$, or according to the notation of Gerhardt, the acids homologous to the radical $C_nH_{2n-1}O$, which I have as yet succeeded in separating from peat liquor are accordingly:—

Formic Acid,	....	$C_2H_2O_4$
Acetic ,,	....	$C_4H_4O_4$
Propionic ,,	....	$C_6H_6O_4$
Butyric ,,	....	$C_8H_8O_4$

It is highly probable that several higher members of the series are present, and may be detected when a sufficient quantity of the mixed salts is operated upon.

Other acids found.

The acids not belonging to the last mentioned series, which have been found, are, *hydrocyanic* acid, and *phenic*, or *carbolic* acid, which is formed in very large quantities. It is probable that this class will also be much enlarged when larger quantities of raw material are employed.

This new source of the acids of the series $C_nH_nO_4$ rendered more interesting by Scherer's discovery of them in mineral waters.

Independent of the theoretical importance of this new source of the remarkable series of homologous acids, their occurrence as products of destructive distillation derives additional interest from the discovery by Scherer of several members of the series in the mineral water of Brükenau, in Bavaria.[11] There can be no doubt that the production of coal is nothing more than a *process of slow distillation*, and that all the substances which are obtained when wood or peat are distilled, are given off in the early stages of metamorphosis of coal-forming organic substances. The origin of the acids in the water of Brükenau is probably the slow decay of subterraneous vegetable matter, perhaps a bed of lignite or brown coal. I shall have some further observations to make on this relation between destructive distillation and the formation of coal in the subsequent papers of this series.

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[11] Annal. der Chem. u. Pharm., xcix., S. 257.

ART. V.—*Observations on some of the Products of the Putrefaction of Vegetable and Animal Substances, and their relation to Pathology. By* WILLIAM K. SULLIVAN.

A BRIEF summary of the observations which form the subject of the following communication, was appended as a note to a paper which I read at the Dublin Meeting of the British Association, and which is printed in the present number of this journal ("On the formation of several of the acids of the series $C_nH_nO_4$, by the destructive distillation of peat"). It had already been put into type in its original shape, when it struck me that the subject being of so much importance, especially in a physiological point of view, my observations might not prove uninteresting, if somewhat extended, and the analytical details added. Such an extension was incompatible with the limits of a note, and I have accordingly made a distinct communication of it.

Mass of wheaten flour set to putrefy several years ago.

Several years ago, I made between thirty and forty pounds of wheaten flour into dough with distilled water, placed it in an earthen pan, covered it with distilled water, and placed in the water and over the mass of dough an inverted funnel, the neck of which communicated by means of a narrow glass tube with the top of a tall narrow bell glass provided with a stop-cock, and inverted over some mercury in a basin. The whole apparatus was laid aside in a cold damp cellar for one year; during this period the mass swelled up, bubbles of gas where evolved which collected in the funnel, and could be made to pass into the bell glass from time to time by opening the stop-cock. The gas collected in this way consisted almost entirely of carbonic acid, but small quantities of marsh gas C_2H_4 and uncombined hydrogen were obtained. Sulphide of hydrogen did not appear to have been given off at any period of the putrefaction; a piece of paper dipped into acetate of lead, suspended in the bell glass for days, did not exhibit the slightest blackening. Protochloride of mercury or basic acetate of lead was not precipitated black by the water standing over the dough.

Gases evolved during putrefaction.

Changes produced in mass

Very soon after the dough was placed in the water the putrefaction set in, but its energy gradually diminished according as the liquor became acid. At the end of the

year the greater part of the mass appeared to have undergone but little true decomposition. Nevertheless, the gluten throughout the whole mass had undergone considerable physical change. It had lost much of its tenacity, the external portion especially forming a soft slimy mass in which quantities of starch globules more or less unaltered were imbedded. A portion of the gluten taken from within about an inch of the surface of the mass, and freed from all adhering starch, was digested with water slightly acidulated with hydrochloric acid at a temperature of 22° C. until it dissolved. This solution examined with a polarimeter presented the power of left-handed deviation in a very feeble degree, compared with a solution of an equal degree of strength made with fresh gluten.

by putrefaction.

At the end of the second year the appearances were but little altered, and it was quite remarkable how little the putrefaction had progressed. That this retardation was caused by the presence of acids in the liquor, was very clearly demonstrated by another experiment made with flour mixed up with ground chalk, and then made into dough and placed in water beside the other mass. In the course of a few months the mass had putrefied more than the other had done after the lapse of two and a half years. In this case a little sulphide of hydrogen appeared to have been formed. Circumstances prevented me from continuing the experiments after this period. But being anxious to determine the nature of the substances dissolved in the water of the flour putrefied without chalk, I placed the whole mass upon a linen strainer, and when it had thoroughly drained, I mixed the mass on the filter with a large quantity of distilled water, allowed the solid part to subside, and decanted off the supernatant liquor, which was then added to that which had drained from the mass. This liquor was mixed with baryta water and distilled until the greater part of the liquor had passed over. The latter was very weakly alkaline; it was neutralized with hydrochloric acid and evaporated to dryness, at first on a sand bath, and lastly over a water bath. This dried mass was then preserved in tubes. The residue in the retorts was then removed, some carbonic acid passed through it, boiled, filtered, and evaporated to dryness, and the dry mass preserved in tubes.

Slowness of putrefaction shown by a second experiment to be owing to the formation of acids in the liquor.

Experiments not being proceeded with, the chlorides of bases and baryta salts of acids preserved.

While these experiments were in progress I also allowed a mass of brain to putrefy under exactly similar

Experiment on

putrefaction of brain.

circumstances. In this case the putrefaction set in with great rapidity, and continued uninterruptedly for several months, because here the liquor never became decidedly acid. Both sulphide and phosphide of hydrogen were evolved during the decomposition of the mass.

Several bases formed during putrefaction of brain.

A very superficial examination of the acid, basic, and other products contained in the liquid in which the brain had putrefied, made at the time, and among which I found valeric acid in comparatively large proportions, and what I believed to have been trimethylamine and some peculiar compound containing phosphorus, led me to believe that a considerable number of the ammonia bases are produced during the slow decay of vegetable and animal substances.

Experiments resumed during the past year.

Having been engaged during the past year in searching for similar bodies among other products, I determined to examine the chlorides and baryta salts from the putrefaction of the flour, which I had carefully preserved in tubes, as above mentioned, but which I had not had time to analyze. The following is a summary of the results which I obtained.

Fractional distillation of mixed chlorides into three portions.

The dried mass presumed to contain the mixed chlorides of several bases, was treated with absolute alcohol, which dissolved a portion of it; the residue was common chloride of ammonium, as was fully established by a determination of the platinum in the precipitate formed by the addition of chloride of platinum and alcohol to a solution of it. The alcoholic solution separated from the chloride of ammonium was evaporated to dryness; the dry mass was introduced into a retort and a quantity of baryta dissolved in water added, equivalent to what would be required to saturate one-third of the acid contained in a quantity of common chloride of ammonium equal in weight to the dry mass put into the retort. The mass was then heated in a water bath, the product of distillation received into water acidulated with hydrochloric acid, the solution thus obtained evaporated, and the resulting dry mass, which I shall call A, preserved for further examination. As much more baryta was added to the residue in the retort and a second product, B, obtained. A third portion of baryta was then put into the retort and a third product, C, found.

Fractional distil-

The product called A was fractionated in exactly the same manner that the whole mass had been, the distillate being subdivided into three portions, *a*, *b*, *c*. The por-

tion *a* was dissolved in the smallest possible quantity of water; bichloride of platinum was then added, and a mixture of alcohol and ether which threw down a double salt possessing all the properties of the ordinary platino-chloride of ammonium. A determination of the platinum in this salt verified the supposition that the substance operated upon was almost wholly chloride of ammonium.

lation of portion A.

A portion of the product *b* was dissolved in water and treated with bichloride of platinum and alcohol, but scarcely any precipitate could be obtained. The whole was then evaporated to dryness in a water bath, but it was found so difficult to effect a separation of the pure compound, that I had to have recourse to the combinations with other metals. Another portion was treated with protochloride of palladium, but although a beautiful salt was formed, considerable difficulty was experienced in separating it in a pure state. Having dissolved the remainder of the product in the smallest possible quantity of water, a very concentrated solution of terchloride of gold was added, which threw down a yellow precipitate that dissolved on the addition of a mixture of ether and alcohol. The solution thus formed was exposed to spontaneous evaporation in a warm place, but shaded from the light. A number of small short rectangular prisms separated, which dissolved with difficulty in cold water; but freely in boiling water, though not without suffering slight decomposition if boiled for some time. This difference of solubility afforded a means of obtaining the salt in a comparatively pure state; the crystals were accordingly dissolved in a small quantity of boiling water; on cooling the compound crystallized out.

Preparation of salts of palladium and gold with the product *b*.

The proportions of gold and chlorine in these crystals were determined by introducing a weighed quantity of them into a small flask, adding some granulated zinc and one drop of diluted sulphuric acid, and allowing the whole to digest for some time. When all the gold was precipitated, the supernatant clear liquid was decanted off, and the residue repeatedly washed by decantation. The precipitated gold was treated with dilute nitric acid in order to dissolve the excess of zinc; the solution was decanted off and added to the previous liquor, and the gold repeatedly washed by decantation as before. When fully washed it was transferred to a small porcelain cup, dried in a water bath, gently ignited, and weighed. All the li-

Mode of determining the amount of gold and chlorine in gold salt.

quids obtained in the washing of the gold were then placed in an evaporating basin, and a little milk of lime added, and the whole evaporated in a water bath to dryness to expel the volatile base. The dried residue was boiled with water, the solution filtered, and a few drops of nitric acid added so as to carefully neutralize the lime; it was then heated to boiling, and nitrate of silver added, to precipitate the chlorine. The milk of lime used, was prepared from lime made with white marble; before being used it was slacked and then mixed with a large quantity of pure water, allowed to settle, the clear liquid decanted off, and fresh water poured on, this operation being repeated three or four times so as to separate any chlorine which might be present. 0.115 gramme of the gold salt all treated in this way gave 0.056 gramme of metallic gold, and 0.165 gramme of chloride of silver. These numbers lead to the conclusion that the body under examination was the aurochloride of trimethylium, $N(C_2H_3)_3,HCl,AuCl_3$, as will be evident from the following comparison:

The base in the portion *b* was trimethylamine.

	Calculated.	Found.
$N(C_2H_3)_3H$ . . .	15.074	. .
Cl_4	35.600	35.441
Au	49.326	48.695
	100.000	

Examination of B.

The dried mass B was fractionated in the same manner as A, into two portions. The first portion consisted chiefly of chloride of ammonium and chloride of trimethylium. The second portion was dissolved in a small quantity of water; a few drops of alcohol were added, and then a solution of bichloride of platinum, as long as any precipitate was formed. The whole was allowed to digest in the liquid for about ten minutes, and was then filtered to separate the precipitate. The latter was treated with boiling water, which dissolved it. When the solution cooled it crystallized out as golden scales of great brilliancy. 0.152 gramme gave on ignition 0.051 gramme of metallic platinum; 0.90 gramme digested with granulated zinc, and then boiled with lime-water, filtered, a few drops of nitric acid added, and the chlorine precipitated by nitrate of silver, gave 0.133 gramme of chloride of silver. These numbers correspond to platinochloride

Preparation of platinum salt.

The base

of amylium, $N\left\{\begin{matrix} C_{10}\ H_{11} \\ H \\ H \end{matrix}\right\}HCl.\ PtCl_2$, as the following comparison shows:— was amylamine.

	Calculated.	Found.
$N(C_{10}H_{12})H$ . . .	30.046	
Cl_2	36.290	36.503
Pt.	33.664	33.552
	100.000	

The solution from which the foregoing salt crystallized out, was still further concentrated at a very gentle temperature and shaded from the light; a very concentrated solution of bichloride of platinum was then added, and the whole set aside in the dark for some days. During this time a crystalline precipitate separated, which was dissolved in boiling water; on being set aside until next day, a quantity of deep orange yellow tabular crystals deposited, but mixed with some of the golden scales of the last salt, and what appeared to be the platinum compound with common ammonia. The whole mass was accordingly digested with zinc, and the solution boiled with baryta water in a small retort connected with a bottle containing water kept cool by ice. The weak alkaline solution thus obtained was about one-third neutralized with hydrochloric acid, and distilled at a very moderate temperature; the product thus obtained was then about two-thirds neutralized with hydrochloric acid, and evaporated to a very small quantity; this was then divided into two portions, to one a strong solution of bichloride of platinum was added, and a few drops of alcohol, a slight precipitate was thrown down, which was separated by filtration; re-dissolved in water and set aside, it crystallized in fine scales. The mother liquor was set aside for some days, when the orange yellow tabular crystals again formed, but still mixed with a small quantity of some other compounds. The whole quantity, amounting 0.125 gramme, was burned, and gave 0.049 gramme of metallic platinum = 39.200 per cent. The body having the nearest composition to this would be platinochloride of ethylium, $N\left\{\begin{matrix} C_4\ H_5 \\ H \\ H \end{matrix}\right\}HCl,\ Pt\ Cl_2$, which contains 39.300 per cent. of platinum.

Treatment of the mother liquor from which the platinum compound of amylamine was separated.

The base present in largest quantity was ethylamine.

Gold salt of ethylamine.

The gold salt was prepared with the other portion of the chloride: it consisted of fine bundles of lustrous golden orange prismatic needles, but containing a little of another gold salt mixed with it. With the extremely small quantity of material at my disposal, I found it impossible to purify a sufficient quantity of the salt for an analysis.

C contained several bases.

The portion marked C, from the first fractioning of the chlorides, apparently contained several bases; but I had not enough substance to enable me to prepare the platinum or gold salts in a state of purity.

Bases found, trimethylamine, etc.

The only bases, accordingly, whose presence I was able to determine with certainty, were, trimethylamine, ethylamine, and amylamine.

Baryta salts yielded acetic, butyric, and valeric acids.

The baryta salts were treated by Liebig's process of fractional distillation, and in other respects in the manner described in my other paper, already referred to; it is therefore unnecessary to describe the process here. The only acids which I could detect were acetic, butyric, and valeric; several higher members of the series are undoubtedly formed by putrefaction; but it would require to operate upon a very large quantity of material in order to be able to separate them. I am also disposed to think that formic acid is also produced by putrefaction. The results which I obtained, although rendering its existence very probable, do not entitle me to pronounce positively upon its presence.

Formic acid probably present.

Negative character of evidence as to the presence of propionic acid.

With regard to the presence of propionic acid, my experiments are rather of a negative character, and certainly do not lead to a definite result. On distilling one of the soda residues (resulting from the partial neutralization of the mixed acids, with a view of separating acetic acid) with phosphoric acid, neutralizing the distillate with baryta, and crystallizing the baryta compound two or three times, which was a matter of considerable difficulty, a salt was obtained having the exact appearance of propionate of baryta. When a solution of this salt was decomposed by carbonate of potash, the solution filtered, evaporated to dryness, and the residue treated with absolute alcohol, no crystalline salt could, however, be separated by the addition of ether, which, it is to be presumed, would be the case if propionic acid was present.

Propionic acid

It is probable that the acid which has been obtained by the putrefaction of lentils, peas, etc., by Bœhme,[1] and

[1] Jour. für Prakt. Chem., xli, 278, (as quoted in Gerhardt's *Traite de Chim.*, *t.* ii., *p.* 440).

which Dessaignes and Chautard[2] believe to be present in spent tanners' bark, may be the butyroacetic, and not true propionic acid, which does not appear to be readily formed in processes of putrefaction. When mangel wurzel or other varieties of beet are stored in heaps, and happen to heat and decay, a good deal of butyric acid is sometimes formed; but I was never able to detect propionic acid, nor could I in putrefied beet juice, although I have operated on a large quantity. F. Keller, nevertheless, states[3] that propionic acid is the predominating acid formed when bran is fermented with animal tissues; indeed, he says the only acids he obtained were acetic and propionic acids. According to him, propionate of baryta contains nine atoms of water of crystallization, which it loses on being heated to 140°. This statement is opposed to the usual opinion that propionate of baryta is an anhydrous salt. Frankland and Kolbe distinctly state[4] that propionate of of baryta dried at 100° has the formula, BaO, $C_6H_5O_3$.

not readily formed during putrefaction.

Keller states that he obtained it.

Strecker[5] observes, that the mixed salts of acetic and butyric acids could be mistaken for propionates, and that the formation of propionic acid in the fermentation of bran, as mentioned by Keller, is by no means proved. He, however, obtained a large quantity of that acid under circumstances which certainly show that it can be formed during putrefaction, if not in the first stages, at least as the result of secondary reactions. In making lactic acid by the modified process proposed by Bensch, that is, by mixing together water, sugar, sour milk, and cheese, the mixture was left for two or three months in a place in which the temperature varied from 20° to 0°. There was formed at the end of this time, besides lactate of lime, a considerable quantity of mannite (as much as 1lb. from 10lbs. of sugar). On allowing such a mixture of lactate and mannite to remain during a summer at a temperature reaching to 20° or 22°, the lactate of lime gradually dissolved, and the evolution of gas continued. After standing for a year, the mass was treated according to Bensch's process for separating butyric acid, but none could be found; the only acids obtained being a large quantity of propionic acid, a small quantity of valeric acid (derived from the cheese), and acetic acid.

Strecker thinks the mixed salts of acetic and butyric acids could be mistaken for propionates.

He obtained it himself however.

[2] Journ. de Pharm., xiii., 244.
[3] Annal. der Chem. u. Pharm., lxxiii., 205.
[4] Annal. der Chem. u. Pharm., xcii. 80.
[5] Annal. der Chem. u. Pharm., lxv. 288.

Great interest in a pathological point of view, which the formation of compound ammonia by putrefaction presents.

The formation of compound ammonia bases in the process of putrefaction is of great interest in a pathological point of view. Indeed I was originally led to institute the foregoing experiments from the belief that such investigations would throw light upon many pathological changes, and from the conviction that the ammonia which is said to exist in the blood in typhus, scarlatina, variola, cholera, and other diseases, is a product of decomposition, and would be found to be oftentimes a mixture of methylamine and other compound bases with common ammonia. That this is the case in the last stages of yellow fever, when the quantity of ammonia (part, at least, being in the state of chloride of ammonium, a body which could scarcely be the result of the decomposition of urea), becomes very considerable, I have not the least doubt.

Discovery that leucine can be formed in the living body.

In the year 1848, I showed[6] (I believe for the first time) that leucine could be formed in the living system, and that, too, without scarcely any organic disease. That body is always a product of the putrefaction of substances containing nitrogen, especially when it takes place under water, and I am consequently inclined to look upon its presence in animal secretions as a proof of putrefactive changes having set in. It is also probable that in every case where leucine is formed during putrefaction, compound ammonia bases will also be found if sought for. Whether this was the case in the liquid in which I observed the leucine, I could not, of course, determine; but it is worthy of remark that creatine was found in comparatively large quantity, while there was but little urea present. Since my discovery of this remarkable substance in an animal secretion, it has been found by several other observers. Frerich and Staedeler, for example, observed it in the human liver, after acute atrophy of that organ, after typhus, etc.;[7] Scherer also found it in the liver of a drunkard who had died of typhus.[8] Gorup-Besanez observed it in normal ox-liver, and also in the pancreas of that animal;[9] a similar observation has been made by Wolff,[10] who, in addition to a large quantity

Fact confirmed by other observers.

[6] Proceedings of the Pathological Society of Dublin. Session 1847–1848, p. 29.

[7] Wien. Med. Wochenschrift, 1850, No. 30, quoted in Gmelin's Handbuch der Chemie (Fortsetzung), Bd. xiii. 2te. Hälfte, S. 75.

[8] Arch. f. Path. Anat., x., S. 228—230.

[9] Annal. der Chem. u. Pharm., xviii. S. 1—43.

[10] Arch. f. Path. Anat., x., S. 228—230.

of leucine, also detected the presence of a homologue of it. Virchow and Frerich have also found leucine in fresh pancreatic juice and in the glands themselves. Most of these observers believe that it is a normal product of the organism; but Virchow[11] has observed it to form and increase after death, and consequently looks upon it as a cadaverous product. That it is found in the living organism is, however, placed beyond doubt by my observation. But on the other hand it is doubtful whether it is ever produced by the healthy action of the organs. That it is a product of decay, though formed within living tissues, is, I think, supported by the circumstance that Gorup-Besanez found several of the acids of the series $C_nH_nO_4$ accompanying it in the liver; and in the mother liquor of the pancreatic tissues from which the leucine was separated, he observed the characteristic smell of the same acids on the addition of sulphuric acid. In connection with this point it would be of interest to determine whether tyrosine and hypoxanthine, which Wolff found in large quantities in the pancreas of the ox, and Scherer in the liver of the drunkard above mentioned (he finds hypoxanthine in all human livers), are always formed during putrefaction along with leucine. Gorup-Besanez found no tyrosine in the liver of the ox, and he thinks the presence of hypoxanthine doubtful.

Is probably always a product of decay.

Are tyrosine and hypoxanthine always formed during putrefaction?

Immediately after Wurtz's discovery of methylamine and ethylamine, I sought for them in several diseased secretions, but did not get any very decided results. I obtained, however, from the sweat of a patient suffering from bromidrosis, a small quantity of ammoniacal chlorides, which yielded, with bichloride of platinum and also with terchloride of gold, crystalline compounds, which appeared when examined under the microscope, to consist of at least three different forms of crystals. I determined the amount of platinum in the mixed salts, and found that the atomic weight of the base or bases was much higher than that of common ammonia. Here also, as in ordinary perspiration, the greatest part of the organic matter consisted of volatile acids—formic, acetic, butyric; but in addition to them, I obtained crystals of baryta salt, which had what appeared to me the exact form of caproate of baryta. These acids, as Lehmann has shown,[12] are not the

Probability of presence of compound ammonias in sweat, etc.

Caproic acid probably present in sweat.

[11] Arch. f. Path. Anat., viii., S. 335—363.

[12] Lehrbuch der Physiologischen Chemie, 2te Auf. 1str Bd., S. 57.

products of the decomposition of the sebaceous substance. The fact of their occurring in normal sweat is apparently opposed to the idea that they are products of putrefaction; but in the present state of our knowledge, no decided opinion can be formed as to how far the presence of the acids of this series can be considered as an indication of putrefaction.

Importance of determining the condition under which compound ammonias are formed in the blood.

Other occupations have hitherto prevented me from pursuing this kind of research; and I do not know whether any one else has turned his attention to the subject. It would undoubtedly be of the greatest importance to determine the pathological conditions under which salts of ammonia are developed in the blood, etc., and whether the compound ammonias are formed in every case where common ammonia is produced. Such investigations would be very much facilitated by a good microscopical investigation of the forms of the platinum, palladium, and gold salts of the ammonia bases, and the publication of a good series of photographic views illustrative of them.

Probability that phosphorus bases are formed during the putrefaction of the brain.

It is also possible that some of the phosphorus bases discovered by Paul Thenard, and which have formed the subject of a recent admirable memoir by Hofman and Cahours, may be formed by the putrefaction of the brain and nervous matter. I hope to be able to resume my experiments on the putrefaction of the latter bodies immediately, and this time on a sufficient scale to enable me to separate most of the substances formed.

SCIENTIFIC NOTICES.

PHYSICS.

1.—*On the Thermal Effects of Fluids in motion.* By Professor W. Thomson and J. P. Joule, Esq.[1]

These researches were made on bodies moving through air with velocities carefully measured by a whirling apparatus. The thermometers in use were filled with ether or chloroform, and were so graduated as to exhibit changes of temperature in extremely small divisions of the centigrade degree. It was thus found that a thermometer having a bulb nearly one inch in length and a quarter of an inch in diameter, would have its temperature raised 1° centigrade by a velocity of 163·7 feet per second. Another thermometer with a much more voluminous bulb, had its temperature raised to a corresponding amount by a velocity of 183·5 feet per second. On wrapping the thermometers successively with paper and with metallic wires, the effect of motion on temperature was considerably increased. With wire the effect was quintupled at slow velocities, thus rendering manifest the influence of fluid friction.

The authors have, on several occasions, noticed the effect of sudden changes in the force of the wind on the temperature of a thermometer held in it. Sometimes the thermometer was observed to rise, at other times to fall, when a gust came suddenly on. When a rise occurred, it was seldom equivalent to the effect, as ascertained by the foregoing experiments, due to the increased velocity of the air. Hence they draw the conclusion that the actual temperature of a gust of wind is lower than that of the subsequent lull. This is probably owing to the air in the latter case having had its *vis viva* converted into heat by collision with material objects. In sheltered situations, such as one or two inches above a wall opposite to the wind, they observed that a thermometer indicates a higher temperature than it does when exposed to the blast.

[1] Proceedings of the Royal Society, No. 27.

2.—*On the Influence of Temperature on the Elasticity of Metals.* By M. Kupffer. *And on the Thermal Effects of Longitudinal Compression of Solids.* By J. P. Joule, Esq.

The results obtained by M. Kupffer are printed in the *Compte rendu* of the Physical Observatory of St. Petersburg. He finds that heat influences both the transverse and torsional elasticity of wires and rods of different metals. The decrease of elasticity for every degree (Reaumur) of increase of temperature is calculated by a formula containing terms deduced by observing the oscillations of rods at different temperatures. Thus, for silver, he finds a decrease of elasticity of 0.000568; for wrought iron, 0.0004696; Platinum, 0.00020110; plate glass, 0.0001242; Swedish iron, 0.0004555; English rolled hoop iron, 0.0004416; copper, 0.0005570; lead, 0.0003035. With high temperatures the loss of elasticity became a little greater.

Mr. Joule[2] finds that heat is evolved by compression, and absorbed on removing the compressing force, in every substance he experimented on. In the case of metals the results agree very closely with the formula in which the longitudinal expansion by heat under pressure is considered the same as the expansion without pressure. He found that the experimental results were generally a little in excess of those calculated, thus indicating what M. Kupffer's researches had already established, namely, that the elastic force of metals is impaired by heat. Professor Thomson has appended some valuable remarks on the alterations of temperature accompanying changes of pressure in fluids, from which it appears that pressure generally increases in a slight degree the temperature of fluids, and that this increase is greater the higher the temperature of the fluid operated upon.

3.—*On the Electro-Dynamic Qualities of Metals.* By Professor W. Thomson.

The author had already communicated to the Royal Society[3] a description of experiments by which he found that iron, when subjected to magnetic force, acquires an increase of resistance to the conduction of electricity along, and a diminution of resistance to the conduction of electricity across, the lines of magnetization. By some experiments made recently, he has ascertained that the electric conductivity of nickel is similarly influenced by magnetism, but to a greater degree, and with a curious difference from iron in the relative magnitude of the transverse and longitudinal effects. Thus, with the same magnetic force, the effect of longitudinal magnetization in increasing the resistance, is from three to four times as great in nickel as in iron, while the diminishing effect of the

[2] Proceedings of the Royal Society, No. 27, p. 564.

[3] Bakerian Lecture on the Electro-Dynamic Qualities of Metals, Feb. 27, 1856, in the Philosophical Transactions.

transverse magnetization is nearly the same in the two metals. In connection with the comparison it may be observed, that nickel was found by Faraday to lose its magnetic inductive capacity much more rapidly with elevation of temperature, and must, consequently, as the author has elsewhere shown,[4] experience a greater cooling effect with demagnetization, than iron at the temperature of the metals in the experiments above mentioned. Professor Thomson further observes, that it will be very important to test the new property for each metal at those higher temperatures at which it is very rapidly losing its magnetic property, and to test it at atmospheric temperatures for cobalt, which, as Faraday discovered, actually gains magnetic inductive capacity as its temperature is raised from ordinary atmospheric temperatures, and which, consequently, must experience a heating effect with demagnetization, and a cooling effect with magnetization.

The present experiments, from the oblong form of the specimens of the metals used, do not admit of founding a quantitative comparison upon them; but the author hopes before long to be able to make a strict comparison between the effects for iron at least, if not for nickel also, and to find for each metal something of the law of variation of the conductivity with magnetizing forces of different strengths.—*Proceedings of Royal Society*, vol. viii., No. 27, p. 550.

4.—*Optics and Painting.*

M. Jamin has published in the *Revue des Deux-Mondes* during the past year some remarkable and highly interesting views on the connection of optics with the art of painting. As Mr. Ruskin's views on landscape painting have been received with considerable favour in these countries, and as many artists are more or less tinctured with the opinions of the realistic school, we thought it might prove useful to give the following abstract of these views, which we translate from that published by the Abbé Moigno in *Cosmos*.

When an artist desires to imitate a scene containing unequally distributed masses of light and shade, he is obliged to attribute to each of them its real value. He must, therefore, measure, or at least estimate, the brilliancy of different objects or of different surfaces, and graduate them in his copy according to the same proportional scale as in the model. For this purpose, he possesses an eye more or less exercised, which, however, as in other men, is a powerless instrument for the exact comparison of luminous intensities. He is, moreover, obstructed by the imperfection of resources of the art of painting; for nature generally presents an absolute brilliancy that no colouring could imitate. Unable to make his picture as perfect as nature, he is forced to darken it; but, for accuracy, he should at least maintain harmony and proportion of lights; that is to say, weaken all the lights in the same proportion. On this con-

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[4] Nichol's Cyclopædia of Physical Science, article "Thermo-Magnetism".

dition alone will his representation be true and faithful. How far has this condition been fulfilled in the most celebrated pictures? in other words, how far are the master-pieces of art true to nature? This is the problem M. Jamin has proposed for solution by the aid of optical science.

More fortunate than the painter, the optician, knowing the imperfections of the eye, has invented photometrical apparatus, by which he can compare the brilliancy of neighbouring objects, and numerically express their relative illumination. By the aid of such apparatus, for instance, he ascertains that the shadow of a stick cast upon white paper has a twentieth of the brilliancy of the portions directly illuminated by the sun. M. Jamin himself has invented one of these precious instruments, of which we shall try to give a general idea. Imagine a small telescope like a single-barrelled opera glass. By putting the eye at the front we see that its interior is divided by a partition. On looking at an object through one of the compartments, a neighbouring object can be seen through the other; and by turning the tube upon itself, the partition may be made to coincide with the line of separation of the two objects. Close to the eye the instrument carries a movable graduated circle. If, continuing to regard the two objects, you turn this circle, you will remark that one becomes more distinct, while the other darkens. Soon the darker object becomes extremely black, while the other attains its maximum brilliancy. The graduation of the circle is so arranged as to show the difference in brilliancy of the two objects by the number of divisions which this circle has to be turned from the zero (found as above) until the objects appear in the field of view with an equal degree of brilliancy. To understand this better, conceive the shadow of a house cast on a white wall. Let us direct the telescope on the boundary line of the shadow; we see in one compartment the brilliant surface, and in the other the shadow; let us now turn the circle until the two parts acquire the same brilliancy, or until we see an equally illuminated surface. The divisions in the circle will then show that the mark which stood at zero at the commencement of our experiment has moved to 20, showing that the illuminated part of the wall is twenty times more brilliant than the shaded portion. Had the wall been yellow, blue, or any other colour, we should have found the same result. Instead of the wall and the shadow of the house, we might consider the ground and the shadow of a tree, a sunbeam and a shadow cast anywhere, the lines of separation of light and shade in a landscape, of a building and the sky, of blue sky and a cloud, etc.—in every case we would have obtained numbers expressing the relative brilliancy of objects contiguous to the field of vision, provided always that the photometer be suitably modified, not only according to the brilliancy, but the tints or colourings of the contiguous objects.

Let us now suppose an artist to have reproduced in a landscape a wall with a shadow, a piece of ground with the shadow of a tree, etc., and let us try to investigate the truth of his representation. The operations are precisely similar to those already described when examining the relations of the objects themselves.

M. Jamin states that after having submitted to the test of his photo-

meter a great number of pictures, he has arrived at the unforeseen result, that in almost all, the proportional relations of the lights differ from those of nature. Always, or almost always, the shadows are not sufficiently deep; light and shade in pictures have also different colouring, so that the photometer, such as described, cannot, as in nature, render the apparent brilliancies of objects exactly equal. A twofold incorrectness is thus everywhere indicated, incorrect proportions of lights, false imitations of tints. Had these deviations from nature been trifling, painting might be admitted to be an approximate imitation of nature; but they are on the contrary very considerable. In the simple case of a body illuminated by the sun, and a shadow cast upon it, the relations found in summer, winter, different hours of the day, fine and bad weather, have been extremely varied. In general the minimum value of the relation of light and shadow is 10, its maximum value 20. But when sunbeams in pictures are examined, we find the above relations comprised between 2 and 4, so that the brilliancy of the sun-light is incomparably weaker in the pictures than in the true landscapes. It is difficult to conceive how the eye can tolerate such considerable inaccuracies. Still, all landscape painters do not deserve this reproach in the same degree; the modern school has made great progress towards exactness; every one may remark that their pictures have deeper shadows and brighter lights; some pictures of Decamps, for instance, present luminous effects comprised within the limits assigned by nature.

The discordance between nature and art in night pictures is not less remarkable. If in one of these pictures, usually lighted by a murky lamp, we compare the light of the lamp with the best illuminated parts, we shall find a relation comprised between 20 and 30. By placing in a room a lighted candle and a sheet of white paper, the ratio of the light of the candle to that reflected from the paper, will be found to be 1500; the candle flame is thus 1500 times as luminous as the paper, while in a picture it is made scarcely 30 times as luminous.

In the most celebrated interiors of Granet, the sky is 4 or 6 times brighter than the window-sashes of the rooms. To test this relation, M. Jamin selected a room with newly-painted sashes, which presented some similarity with those represented in Granet's pictures. By placing his photometer before the window, he found the sky 400 times brighter than the sashes. M. Jamin admits from trial the impossibility of imitating nature in this matter.

Let us now consider a complete landscape: in the foreground, masses of earth, trees, or buildings; in the middle distance, similar objects, seen through a stratum of air, which forms a kind of luminous veil, and increases their brilliancy; in the background, mountains, which blend themselves with the sky; the clouds, whose light far surpasses that of terrestrial objects; the sun, finally, whose dazzling splendour no eye can bear. Measured by the photometer, the luminous intensity of the clouds is several thousand, sometimes several million, times as great as a tree close to the observer. What can the painter do to imitate the infinite gradations in such a scale, when his brightest white has only a

relation 80 times as great in the photometer as ivory-black? If he would adhere to the truth, he would be forced to recognize the existence of scenes which he should not attempt to paint; he should banish the clear sky from his pictures, and never try to represent brilliant clouds. But he can do better by consulting his imagination more than his eye, his interpretation of the reality rather than reality itself, and he will produce a picture possessing indeed only a fictitious reality, but still, charms of life and spirit that will render it acceptable and admired.

To recapitulate, painting is not, as too often supposed, an imitation of nature, but an admitted fiction whose productions do not possess physical reality. Moreover, were it attempted to give the art this character of reality which it wants, insurmountable material obstacles would arise. So that, of all schools of art, the least rational is the realist. Assuming to be accurate, the realists should be guided by photometry; but the photometer proves that they have not even approximated to nature in the relations of their lights. M. Jamin concludes by expressing his satisfaction that physical science should recall to painting its spiritual tendency, which seemed of late about to be forgotten.

CHEMISTRY.

5.—*Electro-Chemistry.*

Professor Miller, of King's College, London, in presenting the first part of a "Report on the recent progress of Electro-Chemical Research", made some observations bearing upon the binary theory of salts, which are especially interesting and important, coming as they do from one who was hitherto one of the ablest supporters of the theory. According to Dr. Miller, the inquiries made of late years in the field of electro-chemistry were characterized rather by modifications of the laws previously admitted, than by any striking or important additions to the stock of scientific truth. Adverting to Faraday's observations of the exceptional conducting power of solid sulphide of silver and one or two other bodies, he stated that it had been shown by the researches of Beetz and Hittorf, that in these cases a true electrolytic decomposition occurred, a circumstance rendered possible by the somewhat viscous condition of the substances which exhibit this anomalous character. The true electrolytic nature of the decomposition was proved, firstly, by the rise of conducting power occasioned by rise of temperature (whereas in metals the effect of heat is exactly the reverse); and secondly, by the effects of polarization observed upon the electrodes between which such bodies are placed.

Allusion was next made to the insulation of metallic bodies by Bunsen, who had shown that in many instances, as in the decomposition of a solution of sesquichloride of chromium, the deposit upon its negative pole

could be made to assume the reguline form, by reducing the surface of this plate to dimensions considerably smaller than the positive plate; a result probably owing in part to the secondary decomposition produced in the limited portion of liquid around the wire, whereby the sesquichloride was reduced to the protochloride of chromium, and subsequently the metal itself was deposited. This view was rendered probable by observing the effects obtained during the electrolysis of sesquichloride of iron, in which these successive stages could be distinctly traced. In cases in which, like the chloride of manganese, the compound was already in the form of protochloride, it was a matter of slight importance whether or not the negative electrode presented a smaller area than the positive electrode. Attention was called to the fact pointed out by Faraday, of the non-existence of more than one electrolyte in multiple series. In the case of the protochloride and of the bichloride of tin, the protochloride only is an electrolyte while in the anhydrous condition. The bichloride is not an electrolyte. Yet, when dissolved in water, itself also not an electrolyte, the solution conducts freely, and a similar result is observed in other analogous cases.

Referring to the decomposition of salts in solution, the bearings of electrolysis upon Davy's binary theory of the composition of salts, was briefly alluded to, and some of the difficulties attending the adoption of this theory in the case of the subsalts were mentioned; these facts, taken in connection with those already alluded to in the case of the bichloride of tin, leading the author rather to the view that a salt is to be regarded as a whole, susceptible of decomposition in various modes, and therefore admitting of representations under two or three different rational formulæ, each of which may, under particular circumstances, be advantageously made use of.

In the discussion which followed the statements of Dr. Miller, Dr. Apjohn observed that the advantages in certain cases, of reducing the dimensions of the anode had been well understood previous to the experiments of Bunsen. It was well known that when Wollaston decomposed water by a succession of electric sparks, he employed this expedient, no doubt because he had ascertained that it facilitated the electrolytic action of the interrupted current on the water.

6.—*On Proto-Sulphide of Carbon.* By M. E. BAUDRIMONT.

The proto-sulphide of carbon, CS, may be obtained by any of the following reactions: 1. In decomposing the vapour of the bisulphide of carbon, CS_2, by spongy platinum or pumice stone heated to redness; under those circumstances CS_2 is decomposed into CS and sulphur, which deposits on the sponge and obstructs its further action; 2. it is obtained during the preparation of bisulphide of carbon, and simultaneously with it; 3. by the decomposition of the vapours of CS_2 at a red heat, in contact with pure lampblack, wood charcoal, and especially animal black in fragments; 4. by the decomposition at a red heat of the vapours of CS_2 by hydrogen; 5. by the calcination of sulphide of antimony with

excess of carbon; 6. by the reaction, at a red heat, of oxide of carbon on sulphide of hydrogen $CO+HS=HO+CS$; 7. by the reaction of sulphurous acid on olefiant gas at a red heat; 8. by the reaction of olefiant gas on chloride of sulphur at a red heat; 9. by the decomposition of sulphocyanogen by heat, etc.

The first process gives the gas sufficiently pure; the other methods give it mixed with sulphide of hydrogen and oxide of carbon. It may be purified by passing it rapidly through a solution of acetate of lead and protochloride of copper dissolved in hydrochloric acid, then drying it, and receiving it over mercury. It is a colourless gas, having an odour which reminds one of the common bisulphide of carbon, but not disagreeable, and strongly etherial. It burns with a beautiful blue flame, producing carbonic acid, sulphurous acid, and a little sulphur. Its density is a little greater than that of carbonic acid. It is not liquefied by the cold produced by a mixture of ice and salt. Water dissolves about its own volume of the gas, but it soon decomposes it into sulphide of hydrogen and into oxide of carbon $HO+CS=CO+HS$. It is scarcely more soluble in alcohol or ether. It is not absorbed by a solution of protochloride of copper. A solution of acetate of lead is not immediately blackened by it, but is after several hours' contact with it, and in the course of several days the gas is completely decomposed, oxide of carbon and sulphide of lead being formed. It is rapidly decomposed in contact with alcaline solutions. With lime-water, for example, the reaction gives sulphide of calcium and an equal volume of oxide of carbon, $CaO+CS=CaS+CO$. No carbonate of lime is produced in this reaction. At a red heat it is slightly decomposed: 1. by spongy platinum; 2. by the vapour of water into HS and CO; 3. more easily by hydrogen into HS and carburetted hydrogen; 4. by copper into sulphide of copper and carbon (graphitoïdal); 5. lastly, mixed with an equal volume of chlorine, a partial condensation takes place, the products formed being the subject of present research by the author.

On analysis made with oxygen in the eudiometer, it yielded equal volumes of carbonic and sulphurous acids, from which the formula CS is deduced. Its composition is, however, perfectly established also by its reaction with lime water, mentioned above. This is also corroborated by the determination of the quantities of carbon and sulphide of copper obtained when the gas is made to act upon that metal. The author promises a complete study of this body, which, he says, several chemists attempted to obtain, but heretofore without success, probably in consequence of water and alkaline solutions transforming it into oxide of carbon and sulphide of hydrogen. M. Persoz has, however, since drawn attention to a passage in his work, *Introduction à l'Etude de la Chimie Moléculaire* (Strasburg, 1837–38, page 117), in which he distinctly points out the fact of the formation of the compound CS during the preparation of bisulphide of carbon, especially if the vapour of sulphur be not rapidly and abundantly produced. He did not, however, examine its properties very minutely.—*Comptes rendus*, *t.* xliv. (11th of May, 1857), *p.* 1000.

7.—*On Caproic Acid.* By M. A. Wurtz.

M. Wurtz has made the very interesting observation, that the caproic acid obtained by Frankland and Kolbe by the action of potash upon cyanide of amyle, exerts a right-handed rotatory power, while it is probable that the same acid, obtained from cocoa-nut oil, has not any such power.—*Annal. de Chim. et de Phys.*, *t.* li. (November, 1851), *p.* 358.

8.—*Researches on the Phosphorus Bases.* By A. W. Hofmann and A. Cahours.

About ten years ago M. Paul Thenard pointed out, in a note on the action of chloride of methyl upon phosphide of calcium,[a] the existence of a series of bodies, which may be viewed as phosphoretted hydrogens, whose hydrogen has been replaced by an equivalent quantity of methyl. The discovery of methylamine, ethylamine, and the other compound ammonias, having given a new and peculiar interest to the subject, the authors took up the unfinished labour of M. Thenard, with a view of completing it, by a careful study of the bodies which he discovered, and by an extension of their number.

Instead of following the method of preparation proposed by M. Thenard, they found that they could procure such compounds more readily by the action of terchloride of phosphorus on zinc-methyl, zinc-ethyl, etc. The bases Me_3P and E_3P, which the authors propose to call respectively, *trimethylphosphine* and *triethylphosphine*, remain united with chloride of zinc, and may be liberated by a simple dilution with an alkali. They are obtained in this way as volatile oils of a peculiar and strongly marked odour, and possessing distinct basic properties.

The following is a list of the compounds which they have studied, and the details respecting the preparation, properties, and analyses of which, form the subject of a lengthened memoir presented to the Royal Society :—

Methyl Series.

Trimethylphosphine,	Me_3P
Platinochloride of trimethylphosphine,	Me_3P, HCl, $PtCl_2$
Binoxide of trimethylphosphine,	Me_3PO_2
Bisulphide of ditto,	Me_3PS_2
Biselenide of ditto,	Me_3PSe_2
Iodide of phosphomethylium,	Me_4PI
Platinochloride of ditto,	Me_4PCl, $PtCl_2$
Aurochloride of ditto,	Me_4PCl, $AuCl_3$
Iodide of phosph' ethyltrimethylium,	(Me_3E) PI
Platinochloride of ditto,	(Me_3E) PCl, $PtCl_2$
Iodide of phosph' amyltrimethylium,	(Me_3Ayl) PI
Platinochloride of ditto,	(Me_3Ayl) PCl, PCl_2

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[a] Comptes rendus, t. xxi. p. 144, and t. xxv. p. 892

Ethyl Series.

Triethylphosphine, ...	E_3P
Platinochloride of triethylphosphine, . . .	E_3P, HCl, $PtCl_2$
Binoxide of ditto, . .	E_3PO_2
Bisulphide of ditto, . .	E_3PS_2
Biselenide of ditto, . .	E_3PSe_2
Iodide of phosphethylium, ...	E_4PI
Platinochloride of ditto, ...	E_4PCl, $PtCl_2$
Aurochloride of ditto, ...	E_4PCl, $AuCl_3$
Iodide of phosphomethyltriethylium, . .	(MeE_3) PI
Platinochloride of ditto, ...	(MeE_3) PCl, $PtCl_2$
Iodide of phosph' amyltriethylium, . . .	$(AylE_3)$PI
Platinochloride of ditto, ...	$(AylE_3)$ PCl, $PtCl_2$

The compounds named in the preceding table exhibit an almost perfect parallelism with the corresponding terms of the analogous nitrogen, arsenic, and antimony series; we have similar formulæ, similar modes of combination, similar decompositions. This analogy is particularly manifest in the compounds belonging to the *ammonium-type.* In these remarkable bodies, nitrogen, phosphorus, arsenic, and antimony, appear to play absolutely the same part. The oxides of these compound metals exhibit almost perfect identity of properties, to such a degree, that a mere study of their reactions would never indicate the presence of elements so dissimilar as nitrogen, phosphorus, arsenic, and antimony; while their alkaline power is so great that they might be confounded with potash and soda. The derivatives of nitrogen are only distinguished from the corresponding members of the phosphorus, arsenic, and antimony series, by the behaviour of the hydrated oxides under the influence of heat.

The compounds formed on the *ammonia-type* exhibit, on the other hand, a gradual increase in intensity of the electro-positive character, as we proceed from the nitrogen to the antimony series. Thus, trimethylamine and triethylamine are not capable of uniting with oxygen, chlorine, bromine, and iodine; while the corresponding members of the phosphorus, arsenic, and antimony series possess this power in a high degree.

Triethylamine unites with the acids producing compounds of the ammonium-type, and containing

$$E_3N, HCl$$
$$E_3N, HSO_4$$
$$E_3N, HNO_6.$$

Chemists have not yet succeeded in preparing the corresponding compounds in the arsenic and antimony series. Triethylarsine and triethylstibine only combine directly with oxygen, chlorine, sulphur, etc., producing saline bodies, which have the composition respectively of—

$EAsO_2$	E_3SbO_2
E_3AsCl_2	E_3SbCl_2
E_3AsS	E_3SbS_2

The two classes are, however, represented in the phosphorus series. Triethylphosphine not only forms compounds analogous to the salts of

triethylamine, but also the terms corresponding to the binoxides of triethylarsine and triethylstibine. Thus:—

Corresponding to salts of Triethylamine	*Corresponding to binoxides of Triethylarsine, etc.*
E_3P, HCl	E_3PO_2
E_3P, HSO_4	E_3PCl_2
E_3P, HNO_6	E_3PS_2

The phosphorus compounds accordingly hold a position intermediate between the nitrogen compounds, on the one hand, and the arsenic and antimony series on the other; but exhibiting a tendency rather towards the latter than towards the former. Considering the close analogies which phosphorus and arsenic present in other directions, this tendency cannot surprise us. Besides the circumstance that the acids of phosphorus and arsenic are polybasic (the acids of antimony have not been yet sufficiently investigated), while those of nitrogen are monobasic, the remarkable connection which subsists between the combining numbers of phosphorus, arsenic, and antimony, may be mentioned. If we compare those numbers we will find that the difference between the equivalents of phosphorus and arsenic is virtually the same as that between those of arsenic and antimony:—

Phosphorus, . . .	31	difference 44
Arsenic, . . .	75	
Antimony, . . .	120	difference 45

whilst the equivalent of nitrogen stands altogether apart from the rest.[6]

The same relative position of the elements nitrogen, phosphorus, arsenic, and antimony, may also be traced in their hydrides, H_3N, H_3P, H_3As, HSb. Ammonia is a powerful alkali; phosphoretted hydrogen unites only with hydrobromic and hydriodic acids, whilst in arsenietted and antimoniettted hydrogen the power of combining with acids has altogether disappeared. In these hydrogen compounds the gradation of pro-

[6] The authors do not appear to have noticed the very singular circumstance that the sum of the equivalents of nitrogen, phosphorus, and arsenic, is equal to the equivalent of antimony:—

Nitrogen, ...	14
Phosphorus, ...	31
Arsenic, ...	75
Equivalent of antimony =	120

The equivalent of nitrogen cannot, therefore, be said to stand apart. Indeed the difference (44 to 45) between the equivalents of phosphorus and arsenic on the one hand, and between arsenic and antimony on the other, noticed by the authors, is nearly equal in the former case, and exactly equal in the latter, to the sum of the equivalents of nitrogen and phosphorus. We may also point out another curious relation between the equivalents of those bodies, which is this: If we add the equivalents of phosphorus and antimony, the sum will be 151; if this be divided by 2, the product will be 75.5, or virtually the equivalent of arsenic.—W. K. S.

perties is, indeed, even more marked than in their trimethylated and triethylated derivatives. On comparing the terminal points of the series, ammonia and antimonietted hydrogen, we cannot fail to be struck by the dissimilarity of properties, which at the first glance appears to limit the analogy of the two compounds to a mere parallelism of composition.

In the methylated and ethylated derivatives of these compounds, the intensity of the chemical tendencies in general is so much raised, that the gradation is no longer perceptible to the same extent.—*Proceedings of the Royal Society*, vol. viii., No. 27.

MINERALOGY AND GEOLOGY.

9.—*Researches on the hygroscopic properties of the minerals of the family of the zeolites.* By M. Damour.

The author, who has already on various occasions pointed out the property which certain minerals possess of losing and again readily taking up the water which enters into their composition, when they are successively submitted to the action of a perfectly dry atmosphere and of a more or less moist one, has made some interesting experiments, with a view of determining within what limits this property is possessed by the zeolites. The following is a summary of his results: 1. the zeolites, with a single exception (analcime), possess the property of losing considerable quantities, and sometimes the whole, of their water of combination, either when placed in a perfectly dry atmosphere, or when exposed to temperatures comprised between +40° C. and incipient redness; 2. zeolites which have been subjected to partial deshydratation, can recombine with the whole of the water which they have lost, by simple exposure to the air; 3. the temperature at which the water is disengaged, without altering the power of the mineral to take it up again, varies with the species of mineral; 4. the facility with which the deshydratation is effected, is usually in direct ratio to the number of equivalents of water contained in the mineral.

These results appear to the author to confirm the opinion that the zeolites, although usually found in crevices, cavities, or veins of certain rocks considered to be of volcanic origin, have been formed by aqueous dissolution, and not, like lavas, by igneous fusion. The author proposes to examine whether the deshydratation of minerals takes place in constant proportions, and corresponding to determinate temperatures.—*Comptes rendus*, *t.* xliv., *No.* 19, *p.* 975.

10.—*On the Gases evolved by the volcanic vents of Southern Italy.* By MM. Charles Sainte-Claire Deville and Felix Leblanc.

Any one acquainted with volcanic regions can easily imagine the difficulties which beset the experimenter in collecting the gaseous emanations which issue from vents. The high temperature of the localities where these vents occur, the suffocating odour of the gases evolved, the disposition of the ground, which renders their collection not only difficult, but often dangerous, and, lastly, the atmospheric conditions under which the greater part of the volcanic orifices are placed, are all so many obstacles to be overcome. The authors, by means of very ingenious apparatus, specially invented for the purpose, succeeded however in overcoming every difficulty; and accordingly, M. C. Deville visited, between the end of May and the commencement of August, 1856, the principal centres of emanations of Vesuvius, the Phlegræan Fields, Etna, Sicily, and the Æolian or Lipari Islands, and collected the gases. These he examined on the spot by means of a small portable laboratory; but, in addition, sixty-six tubes, first exhausted of air, were filled at these various localities, and sealed up by the blowpipe, and brought safely to Paris, where they were examined by the authors conjointly. The apparatus employed in the analysis was that of M. Doyère: the results were also controlled by comparative experiments made by the eudiometer of M. Regnault.

The chief results obtained by the authors may be summarized as follows:—

1. Atmospheric air plays a considerable part in the majority of volcanic emanations, sometimes even preponderating; but this air is almost always impoverished in oxygen, to an extent which, in some of the experiments, reached more than 3 per cent. So that the cone of Vesuvius, for example, may be compared to a kind of downflow chimney, in which certain gases are burned, owing to the high interior temperature, and at the expense of the oxygen of the air which flows in.

2. The higher crater of Vesuvius disengages carbonic acid; but this disengagement takes place through orifices quite distinct from those which evolve hydrochloric and sulphurous acids, and which play a totally different part in the distribution of volcanic forces. This circumstance establishes an analogy hitherto unobserved between certain of the higher fumoroles of Vesuvius, and the emanations of carbonic acid from the volcanoes of New Granada, long since noticed by M. Boussingault.

3. The nature of the gaseous elements escaping by the same orifice is subject to incessant variations. At the grand solfatara of Puzzuoli, the gas, which is expelled at the same time with the vapours of water under strong pressure and a considerable noise, and which deposits chloride of ammonium and sulphide of arsenic, was collected at two different epochs—the 10th of June and 30th of July, 1856, two specimens being collected on each occasion. The following table contains the results of the analyses of these specimens:—

	10th of June.		30th of July.	
	No. 1.	No. 2.	No. 1.	No. 2.
Sulphurous acid .	6.8	6.4	24.7	0·0
Carbonic acid .	0.7	0.0	0.0	5·7
Oxygen . .	92.5	19.4	14.5	18·4
Nitrogen . .		74.2	60.8	75·9
	100.0	100.0	100.0	100.0

From this it will be observed that carbonic and sulphurous acids substitute themselves, the one for the other, and even appear to mutually exclude each other. It may be well to observe that the authors found that the emanations did not contain any combustible gas.

On a previous occasion, M. Ch. Deville[6] observed, at a very short distance from the same place, at the little solfatara, variations of the same kind; not, however, between sulphurous and carbonic acids, but between the latter gas and sulphide of hydrogen—that is, in emanations corresponding to a weaker volcanic intensity.

4. The air at the summit of Vesuvius, and in the neighbourhood of the fumoroles, had the normal proportion of nitrogen and oxygen, and contained no foreign gas. But the air collected on the 30th July, on the shores of Lake Agnano, where, as is well known, carbonic acid is evolved in notable quantities, indicated the presence of that gas in a proportion sensibly higher than that found in normal air, while the oxygen and nitrogen maintained their usual relative proportions. M. Lewy had already observed that the air collected under certain circumstances in New Granada, contained much more carbonic acid than is usually found in the atmosphere.

5. From the analyses of the fumoroles collected on the lava of Vesuvius of 1855, it would appear that the anhydrous and non-acid ones contain a mixture of oxygen and nitrogen in proportions which are sensibly those of normal air, whilst the fumoroles which contain traces of the vapour of water, hydrochloric acid, or sulphurous acid, contain less than the normal quantity of oxygen. The gas of the lava of Vesuvius of 1820, analyzed by Sir H. Davy, and that of the lava of Hecla of 1845, analyzed by Bunsen, appear to be referable to the last category of fumoroles. We might naturally conclude from the preceding observations, that whenever fumoroles containing both hydrochloric and sulphurous acids, disengage themselves not only from lava, but from a volcanic crater or a fissure, similar alterations may be observed in the elements of the air. The following table of the composition of gases corroborates this opinion. The hydrochloric acid and vapour of water are deducted :—

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[6] "Dixième Lettre à M. Elie de Beaumont".—*Comptes rendus*, *t.* xliii., *p.* 747.

	Vesuvius. I.	II.	III.	Vulcano. Fumoroles with Flame.[7]	Without Flame.
Carbonic acid	0.0	0·0	0.0	0.0	0.0
Sulphurous acid	2.6	2.4	0.3	39.1	69.6
Oxygen	18.7	19.7	17.6	5.8	5.5
Nitrogen	78.7	77.9	82.1	55.1	24.9
	100.0	100.0	100.0	100.0	100.0
Relative proportion of oxygen to nitrogen, the sum of the two gases being taken as 100	19.3	20.2	17·6	9.6	18.3

6. The gas of the remarkable fumoroles which escape from the crater of Vulcano, with or without flame, and which deposits boracic acid, sulphur, chloride and iodide of ammonium, and sulpho-selenide of arsenic, traces of phosphorus compounds, etc., is composed of sulphurous acid, and of air poor in oxygen, and accompanied by the vapour of water. Carbonic acid is never present in those fumoroles.

7. The gases of fumoroles characterized by the presence of sulphide of hydrogen and carbonic acid, whether collected at the solfatara of Puzzuoli, the Lake of Agnano, or at Vulcano, and whatever may have been the quantity of sulphide of hydrogen originally present in them, have never yielded the slightest traces of that body in the analyses made in the laboratory. The authors explained this disappearance of the sulphide of hydrogen, by the reaction upon the oxygen of the moist air which accompanied it. Accordingly, the relation of the oxygen to the nitrogen was found to have diminished in some analyses, and to have become, for example, 11 to 89. The authors having found in several specimens considerable proportions of sulphurous acid, a gas notoriously incompatible with moist sulphide of hydrogen, have considered that this anomaly might be explained by supposing that at the very moment at which the gas was collected, reactions might have been produced analogous to those realised by M. Piria in his ingenious experiments relative to fumoroles.

Gas originally containing sulphide of hydrogen never afforded free hydrogen, a circumstance already noticed by Bunsen in the gas of the fumoroles of Hecla.

8. Even in the gases very rich in carbonic acid, like those of the Grotto del Cane, the ammoniacal Grotto of Agnano, and the acid spring of Paterno in Sicily, etc. (gases not containing any oxidizable compound), the ratios of the oxygen to the nitrogen are not those of normal air. For example, at Paterno the oxygen was to the azote : : 14.3 : 85.7.

9. A considerable number of emanations consist mainly of carbonic

[7] The results of two analyses of fumoroles with flame from Vulcano are given in the original, but the second is manifestly incorrectly printed, and we have accordingly omitted it from the table in the text.

acid, or of carburetted hydrogen, or of a mixture of both. If the whole of the gaseous emanations in which the carbon predominates, be grouped together, we may get a series in which the extremes are formed, the one by carbonic acid, and the other by pure carburetted hydrogen, the intermediate terms indicating gradually increasing or diminishing proportions of the one or the other, as we go to one or other extreme. The following table exhibits such a series:

	Macaluba de Girgenti.	Salinelle de San-Biagio.	Salinelle de Paterno.	Lago di Naftia.	Acid Spring of Paterno.
Carbonic acid	1.15	67.00	90.07	94.70	93.23
Oxygen	1.70	0.51	1.00	1.10	0.97
Nitrogen	6.75 }	32.49	{ 3.03	3.52	5.80
Carburetted hydrogen	90.40 }		{ 5.00	0.68	0.00
	100.00	100.00	100.00	100.00	100.00

10. In the gas of the spring of Santa Venerina, on the flanks of Etna, we have commingled the two compounds of hydrogen whose oxidation has furnished the sulphurous acid, the vapour of sulphur, water and carbonic acid of the solfataras. This gas contains:

Sulphide of hydrogen	0.2
Carbonic acid	4.2
Oxygen	0.0
Nitrogen	12.1
Carburetted hydrogen	83.5
	100.0

This and the preceding analyses confirm the deductions suggested more particularly by the conditions under which the gases are evolved.

11. Finally, the authors have been led, by the analyses made at Paris and their subsequent discussion, to consider an active volcano, such as Vesuvius or Etna, as a centre whither emanations representing the products of the combustion of different combustible gases converge according to a certain number of planes geologically determined. In proportion as we go from this centre of activity, following one of the planes of eruption, we find at a given moment in the products evolved, the indication of a combustion less and less energetic. In a word, in taking into account time and space, the nature of the emanations given off from the same point vary with the time which has elapsed since the commencement of the eruptions, while at any given moment the nature of the fumoroles at different points varies with the distance from the eruptive centre.—*Comptes rendus*, *t.* xliv. (*April*, 1857), *p.* 769; *and t.* xlv. (*September*, 21st, 1857), *p.* 398.

COMPARATIVE ANATOMY, PHYSIOLOGY, ETC.

11.—*Researches on the nature of the Crystalline Humour in the different classes of Animals.* By MM. A. VALENCIENNES and FREMY.

The crystalline lens of the eye in animals is composed of three parts: the fibres, the cortical layers, and the nucleus. Hitherto the comparative study of these parts has been but little attended to. The authors have, however, recently investigated the case, and established a number of curious facts, interesting alike to the physicist and physiologist. They have shown, for example, that there is a very remarkable analogy between the crystalline lens and an achromatic one.

It is admitted by all anatomists that the substance of the nucleus is denser than that of the cortical layers: Brewster and Gordon have fully demonstrated this increase of density from the circumference to the centre. Hitherto, however, no chemical differences had been discovered between the different layers of the same crystalline lens. The authors accordingly submitted the lenses of different mammalia, such as the ox, the sheep, the horse, etc., to slow desiccation; all those examined behaved alike, that is, the cortical layers readily exfoliated, whilst the nucleus remained more or less compact. In examining the chemical composition of the different lenses, equal quantities of substance were always used, so as to avoid the errors resulting from operating on unusually concentrated albuminous solutions.

The cortical layers consisted of a noncoagulable albumen, apparently identical with that found by the authors in eggs, and which they propose to call metalbumen, in order to distinguish it from coagulable albumen. It has the following properties:—It dissolves in a large quantity of water; the solution is not troubled by boiling, but coagulated when neutral salts, such as chloride of sodium, etc., or acids, are added to the boiling solution. If it be concentrated at a very low temperature, so as to reduce it to a kind of syrup, resembling the gummy-looking mass of the lens itself, it may be coagulated by boiling, a circumstance which accounts for the coagulation which takes place when the lens itself is submitted to the action of boiling water. It dissolves in concentrated hydrochloric acid, but does not become blue under the influence of the oxygen of the air, as common albumen does. It leaves, on incineration, an ash not exceeding one per cent., and not containing alkaline chlorides. It is very similar to albumen, is precipitated by all the re-agents which throw down the latter, and does not differ much in composition from it.

In äerial animals, the nucleus of the crystalline lens consists of albumen, having the following properties:—it is soluble in water, coagulable by heat, and behaves in all its chemical reactions like the albumen of egg; it leaves more ash than metalbumen, and the ash contains a notable quantity of chloride of sodium; it dissolves in concentrated hydrochloric acid, but does not become blue by the action of air. Its composition

may be considered the same as that of albumen of egg. The albumen is not always found in the centre pure and free from metalbumen; thus it was found in the lens in man, mingled with metalbumen in the cortical layers. When a liquor holding the two in solution is boiled, it simply becomes opaline, and gelatinizes if properly concentrated. The ostrich affords an example of the mixture of both in the nucleus. The proportion of albuminous substances contained in the lens varies with the species of animal, and appears to always increase with age.

It is well known that when albumen is treated with alcohol, it coagulates and becomes opaque. An egg preserved during some time in alcohol, hardens, as if it had been subjected to heat, and its albumen entirely loses its transparency. Its action upon the crystalline lens is different. The cortical layers, composed usually of metalbumen, are rendered opaque when kept in alcohol, while the nucleus sometimes assumes the aspect and semi-transparency of horn. This circumstance, which confirms the difference in chemical composition just established between the cortical layers and nucleus, is of great importance in comparative anatomy and zoology. Owing to this difference of action, the two parts can be distinguished; in some cases, however, the separation is not very sharply indicated, the nucleus remaining opaque, and being only separated from the cortical matter by layers of a gray substance. The authors think that in such cases the albumen and metalbumen are intimately mingled. These results were obtained principally by the examination of the lenses of the following species of mammalia, birds, and reptiles, which had been preserved in spirits for more than thirty years, having been obtained from the museum of the Garden of Plants, and generally put up by Cuvier: *Simia inuus*, *Mustella vulgaris* (Linn.); *Falco fulvus* (Linn.); *Falco ossifagus* (Linn.); *Strix virginiana; Strix aluco; Testudo imbricata* (Linn.); *Chelonia marmorata.*

In some lenses, as in those of the otter, faint outlines of the trisection of the lens in the direction of the fibres, could still be detected. In other animals, the nucleus, which would have become opaque in boiling water, assumes an amber colour more or less deep from the prolonged action of alcohol, and preserves its transparency. In this case, the cortical layers, composed chiefly of metalbumen, and which the action of the alcohol has rendered opaque, detach themselves very sharply from the nucleus, and thus enable many interesting observations to be made on their relative thickness. In the first place, the cortical layers are not equally thick on the two meniscuses of the lens, and great differences may sometimes be observed in the structure of the lens in animals very closely related, such as the horse and the ass. From sections made along the axis of vision, it would appear that the difference in degree between the anterior and posterior curvatures, depends principally on the relative thickness of the cortical layers on both faces; thus, in the ass the thickness on both curves is nearly the same, while in the horse it is greater on the anterior than on the posterior face. These differences are specific, and do not depend on accidental causes acting at the moment of the commencement of the action of the alcohol upon the albuminous parts of the lens. The most singularly

constructed lens observed by the authors was that of an Indian elephant: the opaque layers of metalbumen were accumulated on the front of the lens, and only formed a simple membrane on the back; in this way the posterior curvature was very great, while the anterior face was flattened. This disposition was not observed in any other mamalian animal; it would consequently be interesting to determine whether such a disposition, observed in only one case, occurs in all the individuals of the same species.

From the numerous studies of the lenses of the mammalia made by the authors, it results that the segmentation of the lens varies with the species. In the quadrumania and in several carnivora of the genus Felis, and also in the dog, they found on the anterior face three segments, as in man. In the horse, the otter, the pole-cat, the beaver, the gazelle, the deer, the goat, there are four segments; in the ox there are only three segments; while the number rises to five in the chamois, and even to eight in the gigantic kangaroo. In the lens of the owl three rather indistinct segments were detected.

On examining the lenses, preserved with their capsules in alcohol, it was observed that the capsule is always thin; a lens of the common vulture, however, presented a consistent and very thick capsule. Among the lenses of mammalian animals examined, that of the dromedary was the largest; its diameter was $0^m,021$, that of the nucleus being $0^m,017$. The lens of the lion is also remarkable for its size, the diameter of one being $0^m,018$; the two meniscuses presented the same convexity.

The lenses of birds coagulated by alcohol have not the same aspect as those of mammalian animals; the concentric layers which surround the nucleus are distinguished by a difference of coloration.

Fibres of the lens. The existence of a fibrous substance in the crystalline lens cannot be doubted. It is evidently this matter which retains the albuminous liquid, whose properties have been just stated, in its lenticular form. Kölliker has established that the fibres of the lens are hollow tubes, which contain the albuminous liquor. This fibrous substance is insoluble in water; it is transparent, and becomes opaque when submitted to the action of that liquid; it retains its transparency in contact with strongly albuminous liquids like that of the lens itself: the opacity which the lens assumes when exposed to moist air, is caused by the action of the moisture upon the fibrous matter. The fibres do not consist of fibrine, because they exert no action upon oxygenated water; they are insoluble in ordinary acids, but dissolve rapidly in acetic acid, even when very weak—a characteristic property first pointed out by Kölliker; this solubility cannot be compared to the swelling up of fibrine treated with acetic acid. The fibres have the composition of albumenous substances, but the authors think that the fibrous matter should not be confounded with the latter. The proportion of fibrous substance varies with the consistence of the different lenses; thus in man, where the lens is softest of all, the amount of fibrous matter is almost imponderable; the harder lens of the ox contains somewhat more, while in those of the aquatic mammalia, the quantity augments in still larger proportion.

The crystalline lens in the aquatic mammalia. The authors' observations upon the lenses in this family of animals were made upon those of the seal and several of the cetaceæ. From the observations made on the lens of a seal which had died, it was found that, while its cortical layers consisted of metalbumen, and its nucleus of albumen, like those of aërial animals, its centre was more solid than in the latter; the albuminous liquor is pasty, and is retained by a great number of fibres; owing to this circumstance, when the nucleus is treated with water, a solution of albumen is obtained, which solidifies in consequence of the abundant deposit of fibrous substance, which immediately hydrates and becomes opaque. These fibres dissolve in acetic acid, but much more slowly than the preceding. Thus, the generic characters which separate the mammalia from the fish, exist also in the lens of the amphibious mammalia; but in the latter, the nucleus is nearly solid, and thus, while having the same composition as the mammalian animals, it approaches in some respects the solid lenses of fishes.

Crystalline lenses of fish. The lenses of fish differ completely in composition from those of the other vertebratæ. While the latter, as we have seen, are formed of albuminous liquors differently concentrated, and maintained in the form of a lens by a fibrous substance, the lenses of fish are characterized by a solid nucleus, formed of a substance insoluble in water, and to which the name phaconine, from φακός, a lens, has been given, The cortical layers are formed of albumen, which coagulates by heat, like that of eggs; the nucleus is phaconine, in the form of concentric layers, which are readily reducible to filaments. Phaconine is insoluble in water, alcohol, and ether, is perfectly transparent, and this property is not destroyed by the prolonged action of boiling water. If the filamentous membranes of the phaconine constituting the nucleus of the lens of a fresh fish, be detached before cooking, and be placed in contact with cold water, they become opaque, and swell up. Phaconine is almost insoluble in ordinary acids, and is not transformed into a gelatinous substance by their action; it dissolves slowly in acetic acid; alkalies dissolve it, but with difficulty; this substance, consequently, presents a certain analogy with that which forms the fibres in the lens of mammalian animals. The following table represents the composition of the metalbumen, albumen, and phaconine:—

	Metalbumen from the lens of an ox.	Albumen.	Phaconine.
Carbon,	52.8	51.89	52.11
Hydrogen,	7.3	6.75	7.69
Nitrogen,	16.0	15.46	16.53
Oxygen,	23.9	25.94	23.67
	100.0	100.04[8]	100.00

Phaconine may, consequently, be considered as isomeric with the other albuminous bodies which constitute the lenses of mammalian animals.

The authors were unable to determine the differences which, doubtless,

[8] It is thus in the original.

exist between the two crystalline segments of the double eye of *anableps tetrophthalmus*, the singular disposition of which was the subject of an interesting memoir by M. de Lacepede.[9]

Lenses of the cephalopoda. The solidity of the nucleus formed of phaconine is not the exclusive characteristic of the lenses of fish, but rather of those animals who live exclusively in water. The lenses, for example, of cephalopoda have the same composition as those of fish. The cortical layers are albuminous; the nucleus is solid, and composed exclusively of phaconine. In thus proving an absolute identity between the lenses of fish and those of aquatic mollusca, the authors have established a very curious physiological fact, namely, that the composition of the crystalline lens depends upon the medium in which the animal is to live. In examining the lenses of cephalopoda an interesting fact was discovered, which had not been hitherto noticed by any anatomist, namely, that the lens is composed of two unequal and perfectly distinct segments. In the *Loligo pavo*, the larger segment is more concave than the other, and is always the posterior one. The upper meniscus is perfectly distinct from the posterior one; they may be separated by the slightest shock, and a section of the lens exposed. The cortical layers are formed of albumen coagulable by heat; the nucleus containing phaconine is disposed in concentric layers differently coloured. The authors are desirous of directing the attention of those physicists who occupy themselves with the determination of the direction which the luminous rays follow in traversing the humours of the eye, to this extraordinary structure of the eye, which is the same in all the cephalopoda.

A curious application of the author's researches may be mentioned; they discovered that the transparent bodies found in place of the eyes of some mummies, brought from a tumulus near Arica in Peru, were the lenses of cephalopoda.

They attempt to determine the nature of the eyes of the garden snail, slug, etc., and of those more singular ones which constitute the numerous occuliform and brilliant points which exist between the cilia and the tentaculæ of several acephalæ, such as *Pecten maximus* and *Pecten jacobæus*, etc. All these small eyes appeared to have a kind of small crystalline lens, which hardened on being boiled; but these corpuscles are so small, that they have reserved them for future investigation.

The whole of the results may be summarized as follows:—

1°. That the crystalline lens of a mammalian animal is formed of fibres, insoluble in water, and united at the centre by an albuminous substance, coagulating at about 65°, but becoming transparent and amber-like by the prolonged action of alcohol, and united exteriorly by an albuminous body non-coagulable by boiling under the conditions indicated, not becoming blue by the action of hydrochloric acid, and which has been called *metalbumen*.

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[9] The singular disposition of the eye of *anableps tetrophthalmus*, or *lobitis anableps*, as it was formerly called, to which the authors allude, is the division of the cornea and iris by transverse ligaments, and the existence of two pupils, giving the appearance of a double eye, while there is only one crystalline humour, one vitreous humour, and one retina. This extraordinary fish is found in the rivers of Guyana and Surinam. See Lacepede, *Mém. de l'Institut. National, t. ii., p. 372.*

2°. That these two substances, anatomically distinct, and constituting two different parts of the lens of a mammalian animal, should be distinguished by special names; the name *endophacine* is accordingly proposed for the central portion, and *exophacine* for the external layers.

3°. That the crystalline lens of birds, reptiles, and batracians, differs very little from those of the mammalia.

4°. That the lens of fish is likewise formed of two distinct parts; the one, cortical, or exophacine, is composed of metalbumen; and the other, or nucleus, is formed of an albumenoid substance, solid and insoluble in water, and called phaconine.

5°. That the fibres of the lens of the mammalia, united by albumen or by metalbumen to form the endophacine or exophacine of the lens, have considerable analogy with the phaconine of fish.

Morbid alteration of the crystalline lens. The authors have made some exceedingly interesting and important observations on the alterations which lenses undergo when they become opaque from the effects of disease, as, for instance, cataract. The observations were chiefly made on the lens of the horse, which, as is well known, is sometimes affected by this disease. They discovered that in this case the lens suffers a modification which resembles in a certain degree that which has been observed to take place when a lens is exposed to the action of alcohol or boiling water. The albumen and metalbumen which constitute the healthy lens of a horse, become, by the action of the disease, insoluble in water, and form slightly opaque membranes, which may be readily separated from one another. This modification is not due, as has been supposed, to phosphate of lime, which would modify the properties of the albumen; but, on submitting these membranes to analysis, it was found that they did not leave more ash than ordinary albumen.

[I made, on two or three occasions, some analyses of lenses affected with cataract, which corroborate in a most striking manner the views of MM. Valenciennes and Fremy upon that disease contained in the preceding memoir. The lens was carefully weighed, dried in a water bath, then in an oil bath heated to a temperature of 130°, weighed, then incinerated, and the ash weighed; in no case did I find that the per-centage of ash, and especially of phosphates, exceeded that of a lens quite free from disease. The condition in which I received the specimens was such as to preclude the possibility of my obtaining any accurate results as regards the per-centage of water; nevertheless, I may observe, without desiring to attach much importance to the circumstance, that the diseased lens appeared to always contain more water than healthy ones. It may be well to observe, however, that healthy lenses exhibit a variation in the per-centage of water, within certain limits. It would be interesting to discover whether the opacity of the lens in disease, is the result of increased hydratation.—W. K. SULLIVAN.]

ETHNOLOGY.

12.—*On the Inhabitants and Dialect of the Barony of Forth, in the County of Wexford.* *By* VERY REV. C. W. RUSSELL, D.D., *President of St. Patrick's College, Maynooth.*[10]

[Communicated by the Author.]

Among the minor curiosities of the ethnographical map, one of the most interesting is the occasional occurrence, in the centre of one of the great families of language, of some fragment of another and entirely distinct tongue, which is found to have maintained itself in complete isolation, in vocabulary, in structure, and inflexions, from that by which it has been, perhaps for centuries, surrounded. All the more prominent examples of this phenomenon—as that of the Basque cropping up in the midst of the Italo-Pelasgic group; of the Ossete in the centre of the Caucasian; and the Samoyede in that of the Tartaro-Mongol—have already been the subject of much learned speculation. I allude at present to certain less known and less striking, though, in some respects, hardly less instructive instances, in which the affinities of the intruder with the group amidst which it is found are closer and more appreciable. Such, for example, is that of the well known German dialect of the *Sette Communi* of Verona, and the *Tredici Communi* of Vicenza—descendants of the few stragglers of the Cimbrian expedition into Italy, who nearly two thousand years ago, escaped from the almost total extermination of their army under Marius; or the converse example of the Latin vocabulary and the Latin forms, which have been preserved in the Romani languages of Wallachia, since the days of the Latin colonies planted upon the Danube under the early Roman emperors.

The object of the present essay, however, is not to trace the history of these foreign anomalies, but to bring under the notice of the Section a domestic example of the same singular phenomenon, which, although well known in Ireland, has received but little attention elsewhere, and which, even in Ireland, has never been thoroughly discussed: I mean the peculiar dialect which, up to the last generation, continued to be commonly spoken in the baronies of Forth and Bargie, in the County of Wexford.

A paper on the subject of this dialect, accompanied by a metrical specimen and a short vocabulary, was printed by General Vallancey in the second volume of the *Transactions of the Royal Irish Academy*, and it is alluded to by several writers; but I am not aware that any regular attempt has been made to analyze its elements, or to investigate its character. Vallancey is content to represent it as the ordinary English of the period of the Invasion, preserved unaltered by the descendants of the original colony. But a more common, and in Ireland a more popular opinion, looks upon it as of Flemish origin, or at least, as exhi-

[10] Read at the Dublin Meeting of the British Association, August, 1857.

biting the Flemish element in a very high degree. I purpose, in the following observations, to submit for the consideration of the Section whatever lights upon the question appear to me to be derivable, first, from the history of the colony, and secondly, from the vocabulary and structural or grammatical analysis of the dialect itself.

1. The origin of the colony presents no difficulty. All writers upon Irish history, local and general, agree in considering it as a settlement of the first adventurers, who, in 1169, accompanied the expedition of Strongbow, Fitzstephen, and Maurice Fitzgerald, to Ireland, and to some among whom lands were assigned in the district now known under the name of the baronies of Forth and Bargie. This little band consisted of one hundred and forty knights, and three hundred infantry. The latter, being followers of Strongbow and Fitzstephen, may be presumed to have been recruited in Glamorganshire and Pembrokeshire; and one of the main foundations of the hypothesis of the Flemish character of the language of their descendants is derived from this circumstance. The population of these counties was at that time a very mixed one, consisting not only of Welsh, but also of English, of Normans, and of other foreign adventurers. Among these were a large number of Flemings who had been settled in Wales for nearly half a century previous to the invasion. A terrific inburst of the sea in 1107, and again in 1113, had laid waste the seaboard of the Low Countries, and had driven a considerable body of Flemings for refuge to England, with which country, since the marriage of Matilda, daughter of Baldwin of Flanders, with the Conqueror, a close connection had been maintained. With the English peasantry, however, these foreigners were from the first so unpopular, that the king, Henry I., found it expedient to collect them all into one settlement around the present Haverfordwest, in Pembrokeshire, where they were joined by a subsequent immigration of their fellow-countrymen, who came over as military adventurers in the reign of Stephen I., in 1138.

These Flemish settlements had their centre in the south of Pembrokeshire and the south-west of Glamorganshire, in that peninsula west of Swansea Bay, still known as the Gower district; and that they engaged in considerable numbers in the invading expedition under Strongbow, is inferred from the number of seemingly Flemish names, such as Connick, Colfer, Godkin, Bolger, Fleming, Furlong, Waddick, Ram, Scurlock, Rossiter, Prendergast, Wadding, Codde, Lambert, Parle, and others, which are still to be found in different parts of the county of Wexford, but especially in these baronies of Forth and Bargie. On a closer examination, it is true, this evidence will be found in part illusory. Of the names on which it is founded, some, as Ram and Godkin, are certainly of a date far later than the Anglo-Irish invasion. Others, as Rossiter, Lambert, Prendergast, however Flemish in appearance, are unquestionably Norman or English. Mr. Herbert Hore, of Pole Hore, however, in a learned paper in the *Archæologia Cambrensis* (New Series, iii. 127), clearly proves the Flemish origin of many of the Wexford families. A roll of Wexford men, summoned for military service in 1345, cited by him,

contains several unmistakably Flemish names. And on the whole it is impossible to doubt that the original settlement in the baronies of Forth and Bargie, contained a considerable infusion of that Flemish element which already existed in the population of Pembrokeshire and Glamorganshire. With the view of ascertaining the proportions of the two races at present, I addressed a sheet of printed queries to the clergy of the two baronies, but unfortunately the time was too short to permit any exact conclusions. Thus much, at least, is certain: that a large majority of the names is Norman or English, as Stafford, Devereux, Barry, Hore, Browne, Gifford, Lambert, Roche, Hay, Whitty, Mitton, etc., some of which are still popularly known by the hereditary character embodied in the rhyme :—

Stiffe Staffort,	Stiff Stafford.
Gai Gaffort,	Gay Gifford,
Dugged Lamport,	Dogged Lambert,
Leighen a-Chiese,	Laughing Cheevers.
Proud Derouze,	Proud Devereux.
Criss Colfere,	Cross Colfer.
Valse Vurlonge,	False Furlong.
Gentleman Broune,	Gentleman Browne.

II. But secondly, even were it certain that the Flemish element had preponderated in the population at the time of the original settlement, it may be doubted whether that circumstance could be regarded as conclusive in deciding how far the same element was actually introduced into the language of the colony. It would yet remain to be inquired whether the Flemings of Wales themselves at that period still retained their native language in its integrity. Now, it must be recollected, not only that the Flemings were not the only foreigners then settled in Wales, but also that the Welsh colony of Flemings was, by this time, at least in its second generation. We know, too, that even at the first settlement, Henry I. sent English colonists among them to teach them the English language; and so successful was this policy, that, as early as the time of Higden, it is said of their descendants that "dimissâ jam barbarie Saxonicé satis loquuntur"—(*Higden*, *Gale's Ed.*, p. 210). This Pembrokeshire colony, indeed, was so eminently English, that it was known under the name which Camden himself renders, "Anglia Transwallina"—"Little England beyond Wales". The most, therefore, that can certainly be presumed of the original language of the adventurers who settled in Forth and Bargie, is that the form of English which they introduced contained a certain portion of the Flemish element.

But, whatever was the precise character of the language of these colonists, authorities agree that their descendants preserve, with singular fidelity, not only this language, but also many peculiarities of manner, of social and domestic usage, and even of costume. The most notable of these were maintained in full observance down to the generation before the last, and are well remembered by many old persons still living in the baronies. In the seventeenth century they were almost universal.

In the Southwell MSS., now in the possession of Sir Thomas Phillips, of Middle Hall, Worcestershire, are a series of returns regarding the county of Wexford, written about 1680, and supplied to Sir William Petty, copies of which have been kindly communicated to me by Mr. Edmund Hore of Wexford, to whom I am indebted for much valuable information on the subject of the language. In the first of these returns, which is anonymous, we are told that "they preserve their first language (old Saxon English), and almost only understand the same, unless elsewhere educated"; that "they observe the same form of apparel their predecessors first used", which is, "according to the English mode, of very fine exquisitivelie dressed frieze, comlie, but not costlie"; that they "inviolablie profess and maintain the same faith and form of religion" (of their observances in which particular many most interesting details are described); and that "they seldom dispose of their children in marriage but unto natives, or such as will determine to reside in the barony". There is one of the customs mentioned by him which deserves a special notice. "In summer", says he, "they constantlie desist from all works about ten of the clock, soon after dine, reposing themselves and their ploughhorses until two of the clock, during which time all sorts of cattle are brought home from the field and kept enclosed". Another of the reports in the same MS., by Colonel Richards, an old Cromwellian officer, then governor of Wexford, goes still farther, and not only states that "about high noone men and women, children and servants, naturally cease from labour, and goes to rest for about one hour or two", but adds that "*the cattle doe soe too*—the geese and the ducks repaire into their master's yard, and the cocks and hens do goe to roost for that time, and exactly at the hour!" This usage of the siesta (though perhaps not quite to the extent described by the worthy colonel), has continued down to the generation now living. It is called in the local dialect "enteet", or more properly *nonteet* (noontide)—"the noontide rest".

There is another of the colonel's notices of the barony which will startle you no less. In describing the women of Forth, he assures us that "in one particular they excel all their sex in this kingdom, viz., they so revere and honour the male sex, man, beast, and bird, that, to instance one particular only, if the master of the house be from home, his sonne, if any, or, if none, then his chief servant present, though but a poor plough-driver or cow-boy, shall have the first mess of broath or cut of meat, before the mistress and her female guests, if she have any! This I know, but I have heard it affirmed, that if there be noe man or boy in the house, *they will give the first bit to a cock or a dog, or any male creature!*" Whether it be that the rights of women are now better understood by the fair ones of the barony, or that the tone of the other sex has been elevated since the colonel's day, I am happy, for the honour of modern Forthite gallantry, to add, that of this strange usage I have not been able to discover any present trace.

The same, indeed, might be said of most of the peculiar usages of the district. Fashion in this, as in other matters, has prevailed over traditionary feeling. The youths and maidens of the new generation have

grown ashamed of the ways of their elders, and accommodated themselves in most things to the customs by which they are surrounded; and now almost the only characteristic by which the people of Forth and Bargie are distinguished from their neighbours throughout the county, is their superior industry, intelligence, and thrift.

The language has shared the same fate. Even in 1788, at the time when Vallancey collected the specimens of it which give interest to his paper, it was not without some difficulty that he discovered experts sufficiently intelligent for his purpose; and the vocabulary which he printed was chiefly supplied by an old gentlewoman named Browne, commonly known under the title of "The Madam". An old man named Dick Barry, of Ballyconnor, who lived to an exceeding old age, was probably the last genuine representative of the Forth-speaking peasantry. Hardly one is now to be found in the entire district who uses it as a familiar tongue; and very few, and these only among the oldest Forthers, can be said even to be familiar with the common words of the vocabulary. An address, written by Mr. Edmund Hore, was presented to Lord Mulgrave in 1836; but it must be regarded rather as a pleasant surprise for the good humoured curiosity of that popular nobleman, than a serious literary or political composition. Like Irish in what used to be the Irish-speaking districts, the Forth language has become unfashionable in Forth itself; and the young generation are unwilling even to acknowledge an acquaintance with it, much more to employ it as a medium of ordinary intercourse.

The idea of the Flemish origin of the dialect is comparatively modern. Grose (*Antiquities*, ii. 61) holds it, it is true, to "be a Teutonic tongue, introduced in the first age of Christianity, or perhaps earlier". But no one has ever seriously discussed so wild a theory. I have already alluded to the opinion of Vallancey, that the Forth dialect is nothing more than the English of the invaders. The anonymous report in the Southwell MSS., written in 1682, describes it as "old Saxon English". Colonel Richards pronounces it "the very language brought over by Fitzstephen", and adds that "whoever hath read old Chaucer will better understand it than an English or Irishman". A third contemporary report in the same MS. collection concurs in this view.

Stanihurst, however, with more exactness, while he agrees in regarding English as the substance of this dialect, adds, "that in our daies they have so acquainted themselves with the Irish as they have made a mingle-mangle or gallimaufrere of both the languages, and have in such medley or checkerwise so crabbedlie jumbled them together, as commonlie the inhabitants of the meaner sort speak neither good English nor good Irish". Of the samples of the vocabulary which he gives some are plainly Irish.

If we possessed any satisfactory specimens of the language, this controversy would present little difficulty. Had we some Forther "Tim Bobbin", or even some collection like those of the English provincial songs; had any of our native novelists, by introducing it into their dialogue, done for it what Conscience has done for his native Flemish, or Auerbach for the rude dialect of the Black Forest, it would be easy to

determine its real character. But, unfortunately, hardly any relics of the language are now recoverable, although the old inhabitants declare that, in their early days, songs and ballads in the native dialect abounded in the baronies; in which also I am assured many of the old English ballads, as *Chevy Chase*, *Robin Hood*, etc., were quite common among the people. The Right Rev. Dr. Browne, Catholic Bishop of Kilmore, remembers to have heard, when a boy, a great variety of Forthite songs, said or sung by a blacksmith in his native parish. Mr. Edmund Hore once had met in a number of the *Wexford Chronicle*, of the year 1772, a considerable collection of metrical pieces; but, unluckily, the paper was inadvertently destroyed, and I have in vain appealed to every quarter which seemed to offer a hope of recovering this collection. A few scraps, which, it must be owned, have their full share of the *Fescennina licentia*, are all that I have been able to find. One friend had often heard in his youth a rustic song, commencing :—

Th'ar was a Waddeen in Bollymore,
Th'ar was a hunnert, lackin a score;
Y'ar welcome hartille, y'ar welcome joyes,
Y'ar welcome hartille every one.

The song proceeded to describe the company there assembled, but the only further fragment he remembers is a line about

Ee Vrieste o'paryshe on a long-tailed garrane.

There was another, which began—

A maide vrem a Bearlough,
Anure vrem ee Bake,
E'sholthet ownanoree,
Nich th' his thoras o' Culpake.

One of these maids was bringing to market a *tick* (kid)—the other a basket of eggs; unluckily the kid, in some awkward gambol, jumped against the basket and broke the eggs; and the fun of the piece consisted in the scolding-match which ensued between the fair ones, and in which all the Billingsgate of the dialect is exhausted.

Sometimes the common English ballads contained a few words in the native dialect, generally in the nature of a hit at the Forthers. There is one about a mumming expedition, which, according to the old country fashion, a party of young men from Duncormac made into the parish of Kilmore, where, instead of receiving the hospitality which they expected, they were put off by the canny Kilmore men with regrets and apologies—

In rank and fine order we marched to Kilmore,
Our only intention being mass to procure,
But the hochanny set unto us did say,
"Fad didn'st thou cum t'ouz on zum other dey?—
Fad didn't thou cum t'ouz phen w'ad zum thin to yive?"—
But curse on the churls, 'tis at home we could live.

The only complete piece which I have been able to recover is that printed by Vallancey. I shall give a short account of it, together with the opening and concluding verses, as a sort of text for the observations on the structure of the dialect which it seems to suggest. The theme is

of the simplest. An old yeoman, Walthere (Walter), who is described as "lournagh" and "hachee" ("low spirited" and "out of temper") with the world, in answer to the remonstrance of one of his neighbours, Jone (John), on his downcast and moody appearance, relates how a great match of the well-known rustic game of *commane* or *hurley*, in which two neighbouring parishes were pitted against each other, had been lost through an unfortunate miss on the part of his son, Tommeen. It begins by Jone's demanding—

> "Fade teil thee zo lournagh", co Jone, "zo knaggee!
> Th' weithest all curcagh, wafur, an cornee,
> Lidge w'ous ana milagh, tis gai an louthee
> Huck necher y'art scudden—fartoo zo hachee?"

Walthere replies—

> "Well, gosp, c'hull be zeid; mot thee fartoo an fade;
> Ha deight ouz var gabble tell ee zin go t'glade.
> Ch'am a stouk, an a douel; wou'll leigh out ee-dey;
> Th' valler w' speen here, th' lass i chourch hey".

> "What ails you, so melancholy", quoth John, "so cross?
> You seem all snappish, uneasy, and fretful;
> Lie with us on the clover, 'tis fair and sheltered;
> Come nearer, you're rubbing your back, why so ill-tempered?"

> "Well, gossip, it shall be told; you ask what ails me, and for what,
> You have put us in talk till the sun goes to set.
> I'm a fool and a dunce; we'll idle out the day;
> The more we spend here, the less in the churchyard".

I must refer to Vallancey for the narrative. Walthere proceeds to tell that the game was "jist ing our hone"—all but won by his party—had it not been that by ill-luck his son "Tommeen was ee pit t' drive in"—that is, placed as the player, to give the *barnaughblow*, the decisive stroke, which was finally to drive the ball through the enemy's goal. At first the odds had all been against Tommeen's party, but the scale turned, and they were on the point of complete success. The ball was almost at goal, and needed but a gentle stroke to drive it through, when, instead of a gentle "dap or a kewe", Tommeen, in his unlucky over-eagerness, "yate a risph"—drew a tremendous blow, and, striking his bat upon an anthill, (emothee knockane) shivered it in his hand. Losing the advantage by this unlucky indiscretion, he gave the adverse party an easy victory. Hence the mortification and chagrin of the narrator.

The concluding stanzas, which describe the rough but hearty consolation offered to Walthere by his listeners, are highly characteristic—

> "Ha ha! be me coshes, th' ast ee paid it, co Jone;
> Y'oure w' thee croaken, an ye me thee hone!
> He et nouth fade t'zey ee'lean vetch ee man,
> Twist thee an Tommeen, and ee emothee knaghane.
> Come w'ous, gosp Learry, theezil, and Melchere;
> Outh o'me hone ch'ull no part wi Walthere.—
> Jowane got leigheen; she pleast am all'.—Howe?
> Sh'ya ame zim to doone as w'be doone nowe:
> Zo bless all oure vrendes, an God speed ee plowe".

"Hey ho! by my conscience you have paid it", quoth John.
"Give o'er your crossness, and give me your hand.
He that knows what to say, mischief fetch the man,
Betwixt you and Tommy, and the pismire hill.
Come with us, gossip Larry, yourself, and Miles;
Out of my hand I'll not part with Walter.—
Joan set them a laughing; she pleased them all thaw?
She gave them some to do as we're doing now: (drinking).
So bless all our friends, and God speed the plough".

Meagre as is this specimen of the language, it will at least enable us to form a general idea of its chief structural and grammatical peculiarities. It is hardly worth while to advert to the principles of pronunciation. Many of them are, in the main, those of all the archaic forms of English, at least from the period when English orthography became sufficiently settled to enable us to judge. The hard *g* and *c*, the broad sounds of the vowels, the peculiar powers of the diphthongs, are all very strongly marked in the Forth dialect; and there is a general tendency in it to lengthened and drawling accentuation, which cannot fail to be observed. Many of our modern monosyllables appear in Forth in the dissyllable form—"halluf", "calluf", "moweth" (half, calf, mouth), etc.; and in dissyllables the accent is almost invariably laid by the Forthers on the last syllable.

In the inflections of nouns, pronouns, and verbs, there are some things which call for more special observation. The most ordinary form of the definite article is *ee*, and when the modern article is used, the final vowel is commonly elided. Nouns in the possessive case invariably follow the modern inflection of *s*, instead of the Chaucerian *es* or *is;* and the old plural termination *en* is almost entirely unknown in Forth. The plural of nouns is commonly *es*, which termination, however, is always *a distinct syllable*, and converts a monosyllablic noun into a dissyllable in the plural; as "man, mann*es*". There are a few exceptions, such as, "keyen", kine, "pizzen", peas, "ein", eyes, etc., etc. But it is remarkable that some of the words in which these anomalies occur are also abnormal in modern English itself.

The personal pronouns, with the exception of "ich" (pronounced "itch"), "I", and the old Saxon "hi" (they), are almost the same as in modern English; but in prefixing them to the persons of the verb, as also in prefixing articles, prepositions, and similar particles, whether to nouns or verbs, the final vowel is always elided, even before a consonant. Thus the substantive verb is conjugated, "ch'am", "th'art", "he's" "she's", "w'ar", "th'ar"; so also "ch'ave", I have; "th'ast", thou hast; and in the infinitive, in prefixing the preposition "to", the same elision takes place, even before a consonant, as "t'drowe", to throw.

In the regular verb the terminations of the singular are the same as in the modern English verb; but the plural occasionally follows, in the second and third persons, the old Saxon or Frisian ending "eth";—a form which, for the second person, is familiar to the readers of Chaucer, as in the line,

"Riseth up, sir preest, and stondeth by me".

On the contrary, the old Chaucerian ending of the third person, "en" is unknown in the Forth dialect, as is also the "en" of the ancient infinitive.

The present participle ends in "en", or "een"; and the past retains the old "y" prefix, or "ee", often prefixed to the simple infinitive, as "ee-drowe", from "drowe", "to throw", and sometimes to the participle, as "ee deight". In some participles, however, this prefix is omitted, and some others follow a form almost of purely German character.

The vocabulary has hitherto been chiefly known from Vallancey's paper; but, through the kindness of Mr. Edmund Hore, I have received a very considerable supplement to that collection of words. However strange this vocabulary may appear to one unaccustomed to archaic English, it is impossible to doubt that in the main it is English. A large proportion of the words are perfectly identical with their modern counterparts; and others, as "vorreat", forehead; "bawcoon", bacon; "stuckeen", stocking; "maistreace", mistress, are but broad sounds of the modern English.

Still it is equally certain that many of the words are decidedly un-English. As it may fairly be presumed that the early settlers married in the country, the first mothers of the colony can hardly have failed to leave a trace of their native tongue in its language. Accordingly, notwithstanding Vallancey's assertion to the contrary, the dialect contains a considerable mixture of Irish words; as, "puckane", a goat; "garrane", a horse; "knockane", a hill, etc.

Whether, and how far the Flemish element may be traced in it is much less clear. From what I have already said, it is plain that Flemish must have some influence on the original language; but I am satisfied that this influence was less than has commonly been supposed. It is true that there are some words which at first sight have a very foreign look. Such, for example, are a large class of words beginning, in modern English, with *f* or *p*, but in the Forth dialect, as in the Flemish or Dutch, with *v*; as, vrom, vresh, vroste, voote, vrist, vour, etc. There is also a similar change of *s* into *z*; as, zin, zey, zill (amezil), zitch, etc.; but this seeming identity will appear less conclusive for the Flemish origin of the Forth dialect, when it is recollected that the very same peculiarities occur in almost the entire of the southern group of the provincial dialects of England;—the *z* in the Somerset or Dorset; the *v* in these dialects, and still more in those of Devon and Wilts. So, also, the coincidence of the forms of certain of the numerals in the Forth dialect with the Flemish, by which some persons have been struck, equally occurs in English dialects. Again, the seemingly peculiar Forth demonstrative "dicka", is exactly the Devonshire "thicka"; and I have little doubt that any adept in archaic or provincial English, would find it an easy task to trace the same analogy through the entire Forth vocabulary, with the sole exception of the Celtic portion, to which we have already alluded.

On the whole, therefore, I cannot hesitate to say that the notion of any decidedly Flemish affinity of the Forth dialect appears to me an illusion. Trying it by either or both of the two great rival tests adopted by the opposite schools of comparative philology, I can find no trace whatever of any peculiar Flemish characteristics, whether in its structural forms or in its vocabulary. The inflections of its nouns and verbs

are entirely different from the Flemish: the vocabulary has hardly anything Flemish in it which may not be explained by the common descent of English and Flemish from one German stock; and much that appears Flemish at first sight in the Forth dialect, is equally found in other dialects of English, to which no one has ever dreamed of ascribing a Flemish origin.

If I could have hesitated in this conclusion at all, my doubt would have been removed by the judgment of a distinguished Belgian scholar, a perfect master both of English and of his own language, to whom I sent Vallancey's specimens for examination, and who assures me that there is nothing whatever in them which can be regarded as peculiarly Flemish.

I venture, therefore, to conclude that the Barony of Forth language is a lineal descendant of the English introduced by the first settlers, modernized in its forms, and also, though in a less remarkable degree, in its vocabulary. The latter, indeed, were it not for the large proportion of Irish words which it contains, does not depart very much further from the ordinary English than some of the provincial dialects of England themselves.

A more curious task would be to compare the Forth language with the Gower dialect, or with the popular language of south-west Pembrokeshire, of which the Forth settlement was but a colony, and which, if any inference could be drawn from the affinities of race, ought to be presumed to exhibit the same substantial characteristics. I regret my inability to undertake such a comparison; but I am confirmed, in what I have said of the Forth dialect, by Mr. Latham's opinion, that there is nothing peculiarly Flemish in the kindred dialect of Gower. The only specimen of the Gower dialect with which I myself am acquainted, is the short vocabulary published by Mr. Collins in the *Transactions of the Philological Society.*[11] It contains about sixty words; these, with the aid of my friend, Mr. Edmund Hore, I have compared with the Forth vocabulary; but there are no more than six out of the entire which we were enabled to identify; nor in these is the coincidence very remarkable, as some of them occur in other provincial dialects.

Nevertheless, I cannot help thinking that this curious dialect, even as bearing on the history of the English language, deserves more attention than it has received. It appears to me to partake of the vocabulary of each of the three great English provincial groups—the Northumbrian, the Mercian, and the Saxon, but especially of the last. Moreover, judging from the inflexions of the verb, and from the participial forms, it seems to me to belong to a period especially requiring illustration. And while I am fully conscious of my own inability to do justice to the inquiry, the meeting of the Association in Dublin has appeared to me an occasion on which I might venture to invite to it the attention of others whose studies in English philology will render the task at once easy and interesting.

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[11] A paper on the Flemings in Pembrokeshire in the "Archæologia Cambrensis", New Series, i., 188–42, contains nothing on the language.

THE

ATLANTIS.

Art. I.—*Joan of Arc.*

Extant materials for the history of Joan of Arc.

THE trial of Joan of Arc, at Rouen, lasted in all four months. Unjust in substance, it was conducted with scrupulous adherence to form. She was interrogated repeatedly and minutely as to the particulars of her life, and especially as to her supernatural claims. The interrogatories and her answers, taken down in French by the notaries on the spot, were turned into Latin and embodied in the formal record of the trial drawn up shortly after its termination. Several exemplifications of this record, under the hands and seals of the notaries and the seal of the Bishop of Beauvais, her judge, are in existence. A copy also exists of a great portion of the original minutes of the questions and answers, in French, quite sufficient to testify to the general fidelity of the Latin version. Twenty years after her death, the tardy justice of King Charles VII. caused him to solicit from Pope Calixtus III. the institution of a process for the revision and reversal of the sentence passed at Rouen. After an examination of the record of the former trial by the Auditor of the Rota, and his report upon it (a paper of singular ability), the Pope issued his brief for the process of revision, and after a long investigation the former sentence was annulled and her good name fully restored. On this second trial were examined no fewer than 132 witnesses, including her uncle, Durand Laxart, who had been her first confidant, her other surviving relatives, her godfather and godmother, friends

who had known her from childhood until she set out upon her journey to seek the king, her attendants upon that journey, the Duke of Alençon, Count Dunois, and others her fellows in arms, her own chaplain, squire, and page; lastly, several of the assessors who sat upon her trial at Rouen, the chief notary by whom her answers were recorded, the friar who attended her on the scaffold, and many others present at her death. These depositions, embodied in the record of the second trial, exist in full. In addition to all this, there remain contemporary accounts of her in considerable number, some of them letters written from the camp, almost in the light of her presence. Surely there are few historic personages of an epoch a little removed from our own, whom there are materials of judging so abundant and trustworthy.

Strange to say, with all these means of truth, the memory of Joan early passed into, and long remained in, the twilight region of uncertainty and fable.

Prevalent ignorance and uncertainty respecting her.

Almost in her own day, the Burgundian chronicler Monstrelet gave that ungracious and sceptical account of her, filled with the idle inventions of her enemies, which was followed by writer after writer, till it became doubtful what she was—a heroine or a political tool—a fanatic or cheat—or that mixture of both which is such a favourite character with the philosophic historian. But it was impossible that this indolent acquiescence in uncertainty could subsist before the quickened spirit of research which has marked our age, or that when French history in all its sources became the chosen field of the labours of the foremost in genius among Frenchmen, their inquiries should not turn to "the only being in humanity and history", says Count Louis de Carné, "but for whom France would have ceased to reckon among nations".[1]

But all other labours on the subject of Joan of Arc must yield to the great work of M. Jules Quicherat,[2] brought out by the *Societé de l'Histoire de France*.

M. Quicherat's great work.

M. Quicherat has printed in full the entire of the records of both trials. He has collected every account and notice of her to be found either amongst her own contem-

[1] Revue des deux mondes, 15th January, 1856.

[2] Procés de condamnation et de rehabilitation de Jeanne d' Arc dite La Pucelle, publiés pour la prèmiere fois d' aprés les manuscrits de la Bibliothèque Nationale, suivis de tous les documens historiques qu' on a pu rèunir et accompagnés de notes et d' eclaircissemens, par Jules Quicherat. Cinq volumes. Paris, 1840-1850.

poraries, or writers of the age immediately succeeding. As a matter of mere editing, this work is beyond all praise. Both the Latin and French of the records are printed with great accuracy; but with a just discrimination, while he has throughout corrected the contracted and semi-barbarous spelling of the Latin, he has left the old French in its original garb. The notes alone must have cost a world of labour. There is not a person or locality mentioned in the text (how obscure soever) as to which they do not supply information, which adds to our means of judgment. There is no part of the text throwing light upon another to which our attention is not called by a brief reference. There is also a copious index to the entire. Lastly, M. Quicherat has added an essay of his own, which he terms *Aperçus Nouveaux*, in which he has strictly confined himself to the new light which the documents published by him throw upon many circumstances of her history. In these documents at all events is to be found all that can be known respecting her, and they both bring out her own personal character in the clearest and most definite way, and render the facts of her career as undeniable as any recorded by man.

Impression left by study of the documents.

Yet, at the same time, the study of these documents immeasurably deepens the wonder which attends upon her. It has been often remarked, by way of contrast between the works of man and the natural works of God, that minute inspection beholds the beauty of the former vanish in vulgar and unsightly detail, while in the latter it serves but to reveal their inner and perfect harmony. If the same analogy hold in the moral world, in the comparison between human action and impulse on the one hand, and the operation of a divine influence upon the other, we will find it hard to believe that the actions of Joan of Arc hold of nothing higher than Earth.

Preliminary view of the previous state of France.

Before speaking of her, however, we must look back to the condition of France for some thirty or forty years before —a period unsurpassed in history for its crimes, its distractions, and misery. We must have some measure of the deep need there was of a deliverer,—we must see how black and troubled was the night upon which that healing star arose.

In the reign of Charles V. of France, when the fourteenth century was verging to its decline, France held, as she holds in the nineteenth, the first place amongst European kingdoms. True, she was indeed far from that com-

pact and formidable unity which now marks her, and which, from the rocks of Mont St. Michel to the roots of the Alps (whatever be the strife of parties), makes one sentiment of undivided nationality throb in thirty-six millions of bosoms. She had still all the external attributes of a feudal monarchy, and the lords of her great provinces enjoyed a power never arrogated in England by the haughtiest of the Nevilles or Percies. Yet, although the feudal system was still fully enthroned in the ideas, manners, and jurisprudence of the time, the independent power of the nobility had, during the reign of Charles V., been largely yielding to the power of the crown. The great work of the consolidation of the monarchy was already in progress, in which Louis XI. and Richelieu were afterwards such zealous workmen, and which was crowned and completed by Louis XIV. But in the fourteenth century, the idea which was accomplished in the seventeenth, of annihilating the intermediate power of the nobles, and of bringing the central authority of the sovereign to act directly upon all his subjects, would have been held a monstrous outrage upon the constitution of the realm. The increase of the power of the crown to which we have referred, was brought to pass in a different way,—in a way accordant with the spirit of the age.

Decline of the first and rise of the second feudalism.

Whenever, by the feudal law of escheat, any of the great fiefs became vacant for want of heirs, or was forfeited for treason, either the king absorbed it into the domains of the crown, or, more commonly, granted it as an appanage[3] to one of his own immediate relatives. When the elder house of Burgundy, for example, became extinct in the reign of King John, the father of Charles V., he granted that duchy to his son Philip the Bold; a grant afterwards confirmed by Charles V., thus creating the second and more memorable house of Burgundy. Another of the brothers of Charles V., was Duke of Berri; a third was Duke of Anjou; and his wife's brother was Duke of the Bourbonnais; Normandy had been united to the French crown since the days of Philip Augustus; the great central provinces were the hereditary domain of the crown; and, lastly, Charles V. had in his own day—he and his glorious servant the Constable

[3] *Apanage* (ad panem) was the provision carved out, either by king or vassal, for a younger son. It always reverted on failure of male heirs. See Du Cange, *Apanagium*, and the 95th chapter of St. Simon's memoirs.

Du Guesclin—won back all the conquests which the English, under the Black Prince, had made in the preceding age, leaving them no footing in the kingdom with the exception of the single town of Calais and some petty castles in Aquitaine. Thus the strength of the king and of his family was so great as to leave no power in the realm capable of contending with them. Yet there was in this state of things one manifest danger. So long, no doubt, as the king was personally vigorous and resolute, the power of the great princes round the throne would be likely to remain united and to be his instrument; but, if the sceptre were to pass into wavering or imbecile hands, was it not to be dreaded that each of these princes would, on the other hand, seek to use the royal authority for his own purposes, and that their contending ambitions would rend one another and the land?

Madness of Charles VI., August, 1392.

So it unhappily proved. Charles V., the politic and far-seeing, was no more, and the crown had passed to his son, then a boy. Charles VI. was a prince of fair promise, and as he matured showed no worse faults than those which belong naturally to youth—a love of pleasure—a love of the pomp and circumstance of war—when, in his three-and-twentieth year that visitation befell him which was the source of so great calamities for France. Being filled with just wrath at a foul and all but successful attempt which had been made to murder his favourite the Constable Oliver de Clisson, the king put himself at the head of an expedition to punish the culprit and the Duke of Brittany, who had sheltered him. For some days before setting out, he had been strange and wayward in his manner, by turns silly and moody; and on the journey he received a great mental shock from a maniac, who rushed out as he was passing through the wood of Mans, and seizing his bridle, cried out: "O king, you are betrayed!" The king continued brooding in silence until he passed through the wood and came out upon the plain under the scorching rays of the sun. It was the month of August, 1392, a summer of unexampled heat. One of the pages behind the king, drowsy with the heat, let his lance fall, which struck upon the helmet of his companion. The king heard the clink of the steel, and suddenly shrieked out that he was betrayed, and drawing his sword, rode furiously at his followers, and struck down four of them. He then endeavoured to kill his brother the Duke of Orleans, who was saved from him

with difficulty; and after exhausting himself with frantic efforts, he was at length secured, his eyes rolling wildly in his head; he was in a paroxysm of raging madness. From that day till his death, thirty years after, Charles VI. was never permanently restored to reason, though he had many lucid intervals, sometimes lasting for months, during which he mostly showed himself well intentioned and just, though depressed from the clinging fear of his infirmity, and, of course, for all information as to the past, at the mercy of those around him. But what is still stranger is, that during all that time no regular regency was appointed. All edicts went forth in the king's name, as if he were in full possession of his faculties; and the royal authority thus lay as prize for whosoever could gain possession of his person.

Contests of the princes of the blood.

The Duke of Orleans, the only brother of the king, and the Duke of Burgundy, his uncle, at once arose as the leaders of rival factions, who, in city and country, in open council and secret intrigue, sought by every means to counteract and undermine each other. The Duke of Orleans haughtily asserted his claim, as nearest of blood, but the Duke of Burgundy soon acquired the predominance from his mature age and longer experience, as well as from the power which his own great dominions gave him; for, in addition to the dukedom of Burgundy, he was, in right of his wife, Count of Flanders and Artois, and held under his command the populous cities of the Netherlands, then in the climax of their prosperity, and bursting with commercial wealth. And, in justice to Philip of Burgundy, it must be said that in all his administrative acts there was at least some pretence of public good held forth, some endeavour to relieve the condition of the kingdom; and this moreover, that, whatever was the animosity of parties, they did not, during his life, break out into open bloodshed. But he died in 1404, just twelve years after the commencement of the king's madness, leaving as his heir his son John, who acquired the surname of the Fearless (*Jean Sans Peur*); and rightly was he so named, for he was without fear alike of God or man. He became the inheritor of his father's immense possessions, the inheritor to the full of his father's ambition, and of far more than his father's passion of factious hate. Towards him the Duke of Orleans did not stoop to show that deference which he had been reluctantly forced to pay his father. Ac-

cordingly, with the queen's concurrence, he boldly assumed the powers of regent; and it must be owned, a model of a bad government it was—partial, violent, and rapacious. Such was the detestation with which it inspired the Parisians, that they never could be taught to feel just pity or anger for his cruel end. But the Duke of Burgundy little dreamed of surrendering tamely that power in the central government which his father had possessed. He was prepared to appeal to arms, and both parties commenced to make military preparations, and their troops were drawing near and darkening round the capital. But the Queen and the Dukes of Berri and Bourbon, the uncles of the two rivals, interposed, and succeeded in effecting an apparent accommodation. Orleans and Burgundy were reconciled, they swore a solemn peace with one another, they ratified it by joining in the most sacred rites, and the Duke of Orleans promised to dine with the Duke of Burgundy on Sunday, the 18th of November, 1407. But that day never dawned for Louis of Orleans. On the Friday before it he had been supping with the queen, when a message arrived from the king, desiring his presence. He set out at once after nightfall of a November evening upon a mule, and with but two attendants, through the dark streets of Paris; when on passing the Porte Barbette, he was suddenly attacked with such violence that his hand was cut off. He cried out that he was the Duke of Orleans. The assailants replied that it was he whom they sought, and tearing him from his mule, they murdered him upon the ground, dashing his brains about the pavement. The message sent to him had been a snare—the assassins were satellites of the Duke of Burgundy, and the murder was that duke's contrivance. He tried at first indeed to conceal his crime; but when the Mayor of Paris came before him, in the presence of the Dukes of Berri and Bourbon, and required permission to search his palace to find the assassins, he turned pale and avowed to his uncles that he had procured the deed to be done, at the instigation, as he said, of the Devil. They bade him fly from Paris. He fled, soon to return. The momentary remorse which he had felt was swept away by the returning flood of pride and evil passion, so soon as he felt himself upon his own territory, surrounded by all the realities of power. He returned to Paris, not in chains as a felon and a murderer, but with a Flemish army at his back, and in the

Murder of the Duke of Orleans, 16th Nov., 1407.

hateful form of arrogant and triumphant crime. In the meantime the widow of the murdered prince, Valentine, Duchess of Orleans, a daughter of the Duke of Milan, brought her children in her hand to the foot of the king's throne with a passionate cry for justice. The king loved her much, for her tender Italian nature had often watched over and soothed his malady, when his own wife Isabella of Bavaria, a German, cold and gross, stood estranged and aloof. The poor king mingled his sobs with those of the widowed duchess as he promised that justice which he felt he was impotent to bestow. Impotent indeed! She had to fly from Paris as the Duke of Burgundy entered it with a force which there was nothing to resist, avowing and glorying in his crime. He extorted from the king a full and complete pardon; but something still more disgraceful was to ensue. The circumstances of his crime were peculiarly detestable. The victim was the only brother of his sovereign, his own first cousin, his companion in boyhood, and in early youth his brother in arms, according to the custom of chivalry when chivalry was; and he had slain him with infamous treachery, contrary to the faith of a solemn treaty sworn between them. Yet he procured his own hired orator, Jean Petit, a Norman friar, in the face of the University of Paris, to defend and justify that crime upon the pretext of permissible tyrannicide, in a harangue which is still to be read[4]—a mixture of pedantic sophistry, of perverted Scripture, and misapplied history, and in which the real faults of the murdered duke are mixed up with incredible calumnies. But it serves to give us some measure of the terror which Burgundy inspired, to think that a body like the University of Paris could listen in patience to a doctrine so monstrous—a doctrine which, we have to add, was afterwards condemned and anathematized when that terror was removed.

The Duke of Burgundy avows and justifies his crime.

Death of the duchess.

The Duchess of Orleans, driven from Paris, died soon after of a broken heart; but before her death she summoned round her bed her husband's sons, the young Duke Charles of Orleans, his brothers the Counts of Vertûs and Angoulême, and another who was not her son, but whom, from his high qualities and his zeal in his father's cause, she loved as hers, one whom we shall hereafter find playing a noble part in the liberation of his country, who

[4] It is given in full by Monstrelet.

was then known as the Bastard of Orleans, but who subsequently acquired and made illustrious the name of Dunois. She exacted from them a pledge never to cease the pursuit of their father's murderers—a pledge but too faithfully fulfilled. The Duke of Orleans, too young to be the leader of a party, allied himself in marriage with the daughter of the Earl of Armagnac, a Gascon noble of no great territory, but of an active, daring, and unscrupulous character. He at once became the head of the faction of Orleans; and the civil war which burst out through France became known as the war of the Burgundians and Armagnacs. The details of this miserable war are but a revolting record of blood and rapine. Civil wars are, indeed, proverbially perfidious and inhuman, but all other civil wars in history might be termed honourable and merciful in comparison with this of the Burgundians and Armagnacs. As it sprang from no contest of principles, from no public cause, but from selfish hate and ambition, so it was carried on without one redeeming or ennobling feature. Yet, without studying the details, it is hardly possible to conceive what the wretched country suffered at the hands of both the factions. The soldiers of Armagnac inspired especial horror. They came trooping from the south, those ferocious Gascons, pillaging, slaying, cruel for the sake of cruelty, and mingling with it a brutal levity and impiety, putting the peasants to barbarous tortures to discover their hidden hoards. Yet, they were almost rivalled by the Flemish troops of Burgundy. They indeed did not, like the Gascons, destroy for destruction's sake, but they brought with them their carts and wagons from Flanders, and they swept the French fields and granaries clean, in the spirit of hucksters rather than of soldiers. Again, as we may well conceive, in the suspension of all authority, armed bands of freebooters everywhere arose, who clothed themselves with whatever names suited them, but whose only purpose was plunder. Lastly, the unhappy peasant, whose peaceful labours gave birth to that wealth which was the prize of the combatants, too often driven to despair, flung down the beneficent plough for the destroying sword, and became himself a brigand and marauder. In the words of a contemporary,[5] "all France was as the sea, where every one hath as much sovereignty as he hath strength". The metropolis several

Civil war of the Burgundians and Armagnacs.

Its character.

[5] Alain de Chartres.

times changed masters, and each change was marked with massacres and judicial murders; while each party, who for the time had possession of the king, hurled royal edicts against their enemies as rebels and traitors. Five several treaties of peace were made, sworn to, and violated. Yet, the crowning infamy remains. Both parties vied in seeking to purchase the assistance of the common enemy of their country. The Duke of Burgundy was the first to enter into negociation with Henry IV. of England, but the Earl of Armagnac outbid him. A regular treaty was concluded between the king of England and the Armagnacs, by which, as the price of the military aid which he was to render them, they stipulated to surrender to him all Aquitaine in full sovereignty, and to hold their fiefs in that duchy as his vassals. The death of Henry IV. alone prevented that treaty from being carried into effect, and owing to a change of circumstances, which was no merit in them, the Armagnacs, who had thus bargained for the dismemberment of France, became in the event the champions of her independence.

Invasion of France by Henry V., of England.

Henry V., in the flower of his age and possessed by a devouring ambition, was little disposed to be content with Aquitaine. Regarding France in its bleeding and distracted condition as an easy prey, he asserted a pretension to the crown itself. The grounds of his claim were in the last degree preposterous, involving a denial of the Salic law, the fundamental law of the French monarchy. But the avowed grounds mattered little when he knew and his adversaries knew that the sword made title as well as sanction. Henry amused the French with negociations and offers, until in August, 1415, the red cross was on the seas, and Harfleur was besieged by thirty thousand men. This campaign of Henry in France is familiar to all of us, stamped as it is upon our minds by the grand drama of Shakespeare, perhaps the best of his historical plays,—a genuine English epic, in which the higher qualities of his countrymen, their great capacities for action and endurance, are immortally pourtrayed. Yet this very campaign of Henry is but another example how widely different is the art of victory from that of conquest, and how little the mere winning of battles avails an invader until he establishes an interest in the vitals of the country which he comes to subdue. Cressy and Poitiers, the glories of the preceding age, had passed away as barren of real results, as if they had

been but passages of arms at a tournament, and now the still more glorious victory of Agincourt, where the flower of French chivalry fell or were made captives, served but to open to Henry the road to Calais, that his army might embark in safety for England; and two full years elapsed before he invaded France again. The danger of their country and the insolence of Henry's demands had in some degree united the French, and although the Duke of Burgundy held aloof, his eldest son, the young Count of Charolais, had so much of French feeling that he burst into tears at being restrained by his father's command from leading his troops to join the French ranks at Agincourt. But during the two years of respite the fury of faction blazed out afresh. The Count of Armagnac had made himself master of Paris, and as the inhabitants of that city were always strongly Burgundian, he exercised upon them the greatest cruelty, multiplying executions daily, until a terrible retribution came. A sudden revolution overthrew his power and opened the gates to the Duke of Burgundy.

Battle of Agincourt, (1415).

The Armagnacs were seized and flung in multitudes into prison, until, upon some rumours of an army coming to liberate them, they were all torn from their prisons and massacred under circumstances singularly resembling those of September, 1792. Amongst the victims who thus perished was the Earl of Armagnac himself, a man of great wickedness but great capacity, the head and right arm of his party. Burgundy was therefore once more lord of the ascendant.

Massacre of the Armagnacs (1418).

But John the Fearless was beginning to weary of this long civil butchery. Now on the borders of fifty, his blood was cooling fast, and his conscience was heavy with many crimes. Evil as he had been, he could not see without a pang the English landed once more in Normandy, and city after city falling before them; and his own advances to Henry were now treated with characteristic insolence. He became therefore sincerely desirous of terminating the civil war, and of reconciling himself with the Armagnacs. That party was greatly broken and scattered. Their bravest captains had fallen at Agincourt. Armagnac was slain, and the Duke of Orleans, who had been taken at Agincourt, was a prisoner in England. They had still, however, one important source of influence in their hands. The dauphin, the heir of the crown, now a youth of sixteen, had from his childhood

Murder of the Duke of Burgundy (1419).

fallen under Armagnac influences, and was passionately devoted to their party. He was now joined with Sir Tanneguy Duchatel and the remaining Armagnac leaders. To him the Duke of Burgundy made his proffers of peace and submission. The bridge of Montereau, upon the Seine, was appointed for their meeting, with all solemn pledges of good faith. Three barriers were erected across the bridge with a gate and lock to each. As the Duke of Burgundy entered the second barrier it was ominously locked behind him, and when he was in the very act of kneeling to the dauphin, Sir Tanneguy Duchatel struck him in the face with a hatchet, and the other Armagnacs soon completed the murder.

The dauphin was leaning listlessly upon the barrier when the deed was done. Of actual participation or connivance, he must, we think, be acquitted; but he had been trained in an evil school; he was still but a boy in years, and there was in him a fatal passiveness of character, which led him to accept whatever was done by those around him. In the minds of all men the responsibility rested upon him.

Its evil results. Thus fearfully, after the lapse of twelve years, was the death of Louis of Orleans avenged by a crime equal in treachery, and yet more ominous of ill. It at once annihilated the only hope of a union of Frenchmen against the invader. The Duke of Burgundy's eldest son, now duke, when Count of Charolais, had, as we have seen, wept because he was not amongst the French ranks at Agincourt; but every thought and feeling were now absorbed in a burning desire of vengeance. He solemnly foreswore allegiance then and thereafter to the perjured dauphin, and he placed himself, his vassals, and the power of his dukedom, at the feet of Henry of England. The Queen too, Isabella of Bavaria, who had then her unhappy husband wholly in her hands, entered into the league with the Burgundians and the English. She had conceived for her son one of those unnatural hatreds sometimes, but rarely, seen on the part of mothers; and she was devoted to the interests of her daughter Catherine, whom Henry V. desired to marry. Within eight months from the murder of the Duke of Burgundy, was concluded the treaty of Troyes, perhaps the most ignominious that ever was imposed upon a nation. By that treaty Henry was to marry Catherine; the title of King of France was to be preserved to Charles VI. during the remainder of his

Treaty of Troyes.

life, but all the substance of power was to be given to Henry, with the title of regent; and upon the death of Charles, Henry and his heirs, kings of England, were to remain for ever kings of France. Charles, the dauphin, was solemnly proscribed "on account", says the treaty, "of the horrible and enormous crimes which he has perpetrated in our kingdom of France". It was agreed that no peace was to be made with him, and that Henry was to exert himself to the uttermost in reducing all the towns, castles, and forts, which yielded obedience to him. We may wonder that the blood of France could have submitted for a single day to such disgrace. But the sufferings of France had surpassed the power of human endurance. Of late years the despairing husbandman had even omitted to cast his seed into the ground. Famine had come in the trail of war, and pestilence and dysentery, as ever, in the wake of famine.[6] In the city of Paris alone 80,000 had died in one year, and the very wolves had come to prowl in the streets of the metropolis. Peace! peace! and some strong ruler who would protect life and goods, had become the cry of all hearts. So a great portion of the French nation seemed disposed to acquiesce in the English rule. Henry for the next two years was active in subduing and punishing with stern severity the remaining cities of the north of France which adhered to the dauphin. He was full of great designs. He meant France to be the road for him to the subjugation of Italy, and Italy the gateway to the East. But from his conquests and his projects, from his young bride and his newly won realm, he was suddenly summoned. He died in his thirty-fourth year, leaving an infant son the heir of two mighty kingdoms. He was followed to the grave in a month by the unhappy king of France, whose fatal reign came at last to a close.

Miserable state of France.

Deaths of Henry V. and Charles VI. (1422).

Henry left an infant the heir of both his crowns; but as guardian of that infant, and as regent of the realm of

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[6] "There appeared nothing but a horrible face, confusion, poverty, desolation, solitariness, and fear. The lean and bare labourers in the country did terrify even thieves themselves, who had nothing left them to spoil but the carcases of those poor miserable creatures wandering up and down like ghosts drawn out of their graves. The least fences and hamlets were fortified by these robbers—English, Burgundians, and French—every one striving to do his worst. All men of war were well agreed to spoil the husbandman and the merchant. Even the cattle accustomed to the larum bell, the sign of the enemy's approach, would run home of themselves, without any guide, by this accustomed misery".—*De Serres*: see notes to Southey's Joan of Arc, and Creasy's Decisive Battles, p. 316.

France, he left his brother the Duke of Bedford,[7] a prince to the full as brave and politic, and almost as stern, as himself, and devoted heart and soul to the maintenance of the English power in France. The dauphin, on the other hand, was inert, suspicious, and irresolute. Upon his father's death he had assumed the title of king Charles VII.; but he was more in the condition of a wandering fugitive than a king. The Parisians, who had always been strongly Burgundian, mocked him, and called him king of Bourges; and his mother, whose monstrous hatred unceasingly pursued him, did not scruple to blast her own name and character in the falsehood which she invented to destroy him, for she gave out that he was not the son of Charles VI. He had made one great attempt, chiefly with his Scottish auxiliaries, under Archibald, Earl of Douglas, against the English, but his forces met a signal overthrow on the field of Verneuil. Destiny seemed to have declared irrevocably against him. North of the Loire, that is, in the greater portion of France proper, the English and Burgundians were complete masters; and if the provinces of the south still nominally adhered to him, it was more for preserving their own semi-independence, than from any allegiance to the house of Valois. What grasp he had upon the country was diminishing day by day. In the centre of France one great stronghold alone still remained true to him—the city of Orleans. Accordingly, the English directed all their force to that city, and laid vigorous siege to it in the autumn of 1428. Dunois threw himself into the town, and the Orleanists made a gallant defence; but the English won the outworks built by the French upon the bridge across the Loire, and they built round the city six strong forts called bastilles, from which they assailed it on every side. Charles sent a force of French and Scots to relieve the city and to intercept a convoy of provisions coming to the besiegers; but this force was met by the English general, Sir John Fastolfe, and almost annihilated in the battle of the herrings.[8] After this defeat, the fate of Orleans seemed sealed, and the citizens opened a negociation for the surrender of the city, not indeed to the English, but what was in truth

Desperate condition of Charles VII.

Siege of Orleans (1428).

Negociations for

[7] Shakespeare's John of Lancaster, the same sober-blooded boy, who liked not Falstaff. It is uncertain how the error of calling him *Duke* of Lancaster crept in.

[8] The salt fish intended for the English was scattered about the field. Thence the name of the battle.

the same thing, to the Duke of Burgundy. With the fall of Orleans, Charles would have had no sustainable footing north of the Garonne, nor could he have prolonged the war for any time behind that river. He was now at the castle of Chinon in Touraine, seeking by the distraction of vulgar pleasures to deaden the sense of his misfortunes. In truth he despaired of himself and of France. Overwhelmed with such a course of disaster, his mother's slander sank into his mind, and he began to doubt whether Providence had not declared against his lineal right, and he meditated a total abandonment of France and a retreat into Spain or Scotland. Then would have been accomplished all the aspirations of Henry V., and the heirs of Plantagenet would have been fast enthroned in the seat of Charlemagne— surrender.

> "Ruling with large and ample empery
> O'er France and all her almost kingly dukedoms".

But it was not to be. Providence had not decreed that France, whose part in the drama of history was to be so magnificent,—the preceptress of Europe, in the foremost rank of civilization, of science, and of arms,—should have her grand career cut in two, her nationality strangled, and her people dragged at the chariot-wheels of a proud and unsympathetic rival. Nations do indeed, like individuals, accomplish their appointed tasks—some in action and some in suffering; and perhaps our own country in her subjection has fulfilled as providential a mission as any other people in their glory. But the destiny reserved for France was different. In another hundred years from the time of which we speak, came the great revolt against the Church, in which France, humanly speaking, held the balance, and it was not in the designs of Providence that she should be in that hour the servant of England. The cause of France, in all human calculation, was lost; but it is when human efforts and human foresight are most at fault, that the superhuman ways of God seem most wonderful in their simplicity and might.

Belief of the people in a coming deliverer.

From the narrative which we have gone through, we might fancy that all sense of religion, all thought of the laws of God, were extinguished in France, and that the nation was steeped in impiety and crime; but it was far from being so. There had been indeed dreadful wickedness, dreadfully chastised; but it is not from the baseness of courtiers or the ferocity of soldiers that we are to

judge the great body of the people. The peasantry of France remained, as they still remain at this day, faithful and devout, and there had even sprung up in their great misery, a certain mystic tendency, a persuasion that God would in some unforeseen way redeem and relieve them. This belief had taken definite form, and a prophecy was current, that France, ruined by a woman, would be saved by a woman, and that a virgin from the Marches of Lorraine would be the saviour of the land![9] So when Charles VII., in the Lent of 1429, was lying in his castle of Chinon, dissolute and desponding, there came a floating murmur to his ear, growing daily stronger, that the destined deliverer was at hand; till at length it was announced to him that a maiden in man's garb sought his presence, who declared that she was commissioned by Heaven to raise the siege of Orleans, and to seat him upon the throne of France. That maiden was Joan of Arc.

Birth of Joan.

She was then just seventeen years of age. She was born on the day of the Epiphany, 1412.[10] Her parents, Jacques D'Arc and Isabelle Rommée, were peasants of the village of Domremy, in the valley of the Meuse. Across the river, at a little distance, arose the hills which were the border-land of Lorraine. By some unexplained singularity, the inhabitants of this valley, though surrounded on every side by English and Burgundian garrisons, and separated by eighty leagues of hostile country from the provinces held by Charles VII., had preserved their fidelity to the house of Valois. The village boys of Domremy often fought the boys of the neighbouring villages in this quarrel; and Joan in her childhood frequently saw them return bleeding from their combats.[11] The cottage of Joan's father was close to the village church, and not far was that fairy tree, of which use was afterwards made in vainly trying to charge Joan with superstition—a spreading beech, round which the children danced, and upon whose branches they hung their chaplets of flowers to our Lady of Domremy. She herself was simply and well

Fidelity of Domremy to the house of Valois.

Her childhood.

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[9] "Prophetisatum fuit quod Francia per mulierem deperderetur et per unam virginem de Marchiis Lotharingiæ restaurari debebat".—*Procès*, vol. ii. p. 447.

[10] Quicherat, vol. v. p. 115.

[11] "Interrogata si unquam fuit cum pueris qui pugnabant pro parte illa quam tenebat, respondit quod non, unde habet memoriam, sed bene vidit quod quidam illorum de villâ de Domremy qui pugnaverunt contra illos de Maxey inde aliquando veniebant bene læsi et cruentati".—*Procès*, vol. i. p. 66.

brought up; taught her *Pater*, *Ave*, and *Credo;* taught to spin and sew; so that she said long afterwards that she did not fear to meet any woman in Rouen in sewing and spinning.[12]

She attended almost wholly to the house, but rarely going to the fields to keep her father's sheep.[13] In her childhood she was remarked for a fervent, yet grave and simple piety, taking especial delight to hear the church bells ring.[14] So she grew up, until, in her thirteenth year, one summer noon, in her father's garden, she heard a voice addressing her on her right hand, towards the church, and she saw at the same time a bright light. She was filled with a great fear. The voice exhorted her to personal goodness, and told her to frequent the church, and that she would thereafter have to go into France.[15] Soon after, she commenced to see visions of angels and saints. St. Michael was the first that appeared to her, and he told her that St. Catherine and St. Margaret would come to her, and that she should act through their counsel, for that they were ordained by God to guide and counsel her in that which she was to do, and that she was to place faith in them, for this was by the command of God.[16]

Commencement of her visions in her 13th year.

St. Catherine and St. Margaret visited her, and to them she made a solemn vow of virginity. These visions continued from time to time for four years, during which Joan pondered them in her heart, but never spoke of them to any human being. No change was ob-

She makes a vow of virginity.

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[12] "Interrogata utrum in juventute didicerat aliquam artem, dixit quod sic; ad suendum pannos lineos et nendum: nec timebat mulierem Rothomagensem de nendo et suendo".—*Procès*, vol. i. p. 54.

[13] "Dum erat in domo patris vacabat circa negotia familiaria domûs nec ibat ad campos cum ovibus et cæteris animalibus".—*Procès*, vol. i. p. 54.

[14] The sexton of Domremy tells us how she promised to give him wool for diligence in ringing.

[15] "Confessa fuit quod dum esset ætatis xiii annorum ipsa habuit vocem a Deo pro se juvando ad gubernandum. Et primâ vice habuit magnum timorem. Et venit illa vox quasi horâ meridianâ, tempore Æstivo, in horto patris sui, et ipsa Johanna jejunaverat die præcedenti. Audivitque vocem a dextro latere versus Ecclesiam. Et raro audit eam sine claritate. Illa vox docuit se bene regere, frequentare Ecclesiam, et eidem Johannæ dixit necessarium esse quod ipsa Johanna veniat in Franciam".—*Procès*, vol. i. p. 53.

[16] "Et dixit ultra quod Sanctus Michael quando venit ad eam dixit sibi quod Sanctæ Catharina et Margarita venirent ad ipsam, et quod ipsa ageret per consilium ipsarum quæ erant ordinatæ pro eam conducendo et ei consulendo in eo quod deberet agere: et quod hoc erat per præceptum Dei".

served in her, except her increasing piety and self-denial. Her charity to the poor especially was extraordinary. She was known to lie upon the floor that she might give them her own bed. And this great affection for the poor was a trait which marked her afterwards in the days of her greatest glory. In the beginning of the year 1429, her voices became more urgent and specific. They told her that the time was now come—that she had been chosen by God to deliver the kingdom of France from its enemies, and that she was to make her way to the king at Chinon, and demand from him troops to raise the siege of Orleans. "But how", said she, "my lord, can I do that? for I am a poor maiden, knowing neither how to ride nor to command in war".[17] Her voices told her to communicate with Sir Robert de Baudricourt, captain of the neighbouring town of Vaucouleurs, and that he would give her an escort to conduct her to the king. She opened herself first to her uncle, named Durand Laxart,[18] and implored of him to speak to de Baudricourt. She told no other of her family, and yet a sense of something uncommon commenced to spread respecting her. Her father dreamed that he had seen her depart from his house accompanied by men at arms, and he declared that if he thought such a thing possible, he would drown her with his own hands;[19] and a plan was even devised for fixing her at home. A young man of the village averred that she had promised him marriage, and (evidently with her parents' connivance) summoned her to the bishop's court at Toul. She attended, and put an end at once to the pretence. That recourse was had at all to such a device, shows what solicitations to marriage she must have resisted. Her uncle at length brought her with him to Vaucouleurs, and went himself to convey her message to de Baudricourt. The old knight burst into incredulous laughter, and told her uncle to bring her home and punish her. But when Joan herself made her way to him, her fervent convictions could not fail to work upon him. He felt it was something more than natural, and his first thought was to have her exorcised. To this ceremony she joyfully submitted, kissing the priest's stole when it was laid upon her. De Baudricourt then wrote about the matter to

She is told to communicate with De Baudricourt.

His reception of her.

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[17] "Quod erat pauper filia quæ nescivit equitare nec ducere guerram".—Procès, vol. i. p. 52.

[18] See his evidence, Procès, vol. ii. p. 444.

[19] Procès, vol. i. p. 132.

the king, and in the meantime sent her to Nanci to the Duke of Lorraine. That duke, who was prostrated by sickness, hearing a rumour of her supernatural claims, desired to see her, and asked her about his malady; but she answered at once that she was a simple girl—that she had no other mission than to give back the kingdom of France to the dauphin, and that she had neither knowledge nor power in the affairs of other princes. When she returned from Nanci to Vaucouleurs, Robert de Baudricourt would no longer oppose her departure, and two young men, Jean de Metz and Bertrand de Poulengy, who had been fired and subdued by her words, proffered themselves as her guides, putting their hands in her's (the feudal symbol of allegiance), and swearing to lead her to the king. Then Joan, in obedience to the command of her voices, abandoned her woman's dress, her peasant's russet gown, and put on that male attire to which she clung so perseveringly, and which, about to take part, as she was, with men in camps and war, was counselled, as she herself insisted, by every dictate of prudence.[20]

Till her departure was accomplished Joan knew no rest. "She seemed straitened, like a woman", says one of the witnesses, "who expects her time".[21] At length she set out with her guides and their servants, and bade farewell to the valley of the Meuse, never to look on its familiar waters more, though she beheld the mightier Loire and Seine red with her own victories. The little company who thus left a nameless border-village to confront the power of England, to rescue beleaguered cities, to enthrone dynasties, and to change the course of European history for ever, were six in all. Vaucouleurs was upwards of a hundred leagues from Chinon, and the road was full of English and Burgundian soldiers. Yet they passed in perfect safety. Joan rode like a man-at-arms, calm, but elate and confident, sorrowing only that they were obliged to keep away from the churches and from hearing Mass. Yet she stopped for a time at Fierbois praying devoutly in the church of St. Catherine, and from that

She sets out from Vaucouleurs.

[20] Minute details as to this dress are given by Jean de Metz and Bertrand de Poulengy in their evidence on the trial of revision; "ipsa dimisit suas vestes mulieris rubei coloris et fecerunt sibi fieri tunicam et vestimenta hominis".—Poulengy, vol. ii., p. 257; it is evident that it was designed with the view of protecting her innocence. "Portabat caligas ligatas multis ligis fortiter colligatis".—vol. iii. p. 147.

[21] "Et erat tempus sibi grave ac si esset mulier prœgnans". Catherine de Royer.

town she sent to Charles to announce her coming. On the twelfth day they reached Chinon. Charles was most reluctant to receive her. His own nature was cold and eminently distrustful, and his immediate advisers were men of crooked policy, to whom everything enthusiastic was hateful. But the popular fervour was now so great that he was compelled to yield. He received her in the evening in the great hall of his castle at Chinon, which was lit with fifty torches. He was surrounded by many lords and by more than three hundred knights. The king hid himself on purpose amongst his courtiers, yet she walked direct to him and embraced his knees. He said he was not the king. "Ah, gentle dauphin", said she, "my name is Joan the Maid. The King of Heaven has sent to you by me, that you will be crowned and consecrated in the city of Rheims, and that you will be lieutenant of the King of Heaven, who is King of France". The king still looked coldly upon her, when she added, in a low voice, a sentence by which he was thunderstruck. We mentioned that Charles in his profound discouragement had doubted of his own legitimacy; and he had one day fervently prayed to God to make him in some way know with certainty, if he were of the blood of the kings of France, and if so to deign to preserve his crown, but if he were not, to permit him to escape into Spain or Scotland. Of this prayer, of these mental doubts, no human being knew. Now, when Joan saw that he still mistrusted her, she said to him: "I come to tell you, on the part of my Lord (*Messire*), that you are true heir of France and son of the king, and I will lead you to Rheims to be consecrated"; and she added the particulars of his prayer.[22] He no longer thought of rejecting her, but before accepting her aid, he put her through another ordeal, for which he cannot be censured. He sent her to Poitiers to be examined by the college of ecclesiastics there, for the supernatural might spring from an evil source, and the wicked spirit might have clothed himself as an angel of light. She was there for three weeks, closely examined and sifted as to every particular of her

Her reception by Charles.

She tells him of his secret prayer.

Her examina- at Poitiers.

[22] Alain Chartier, the secretary of Charles, mentions in a letter written by him shortly afterwards (July, 1429), that what she said privately to the king no one knew, but that every one saw the change which she wrought in him—"Quod locuta sit, nemo est qui sciat illud, tamen manifestissimum est regem velut Spiritu non mediocri fuisse alacritate perfusum"—and Charles long afterwards confessed that she told him distinctly of his secret prayer, and the place and circumstances under which it was made—*Procès*, v. p. 257.

life and her revelations, and she answered always with perfect simplicity and unwavering consistency.[23] One of the objections raised to her was, that if God wished to deliver the kingdom of France, He could do it without soldiers. "Ah, my God", she said, "the men-at-arms will fight, and God will give them the victory"; and when asked how she hoped to be believed without a sign, she said she was not come to Poitiers to do signs or miracles, that her sign would be to raise the siege of Orleans. "Give me", she said, "men-at-arms, few or many, and I will go". They decided at last that the king might lawfully use her services.[24] So he gave her a suit of white armour, and the Duke of Alençon bestowed upon her a black war-horse, but she still wanted a banner and a sword. For the sword she bade them send to the town of Fierbois, and in the church of St. Catherine to dig inside the altar, and they would find underground, though half corroded with rust, a large sword with five crosses marked upon the blade. The *curé* of Fierbois was written to, an armourer of Tours was sent to make the excavations, and the sword was found just where she had indicated, and in such a way as to exclude the possibility of fraud. Her banner she had made according to the commands which she received from her voices. On it were painted the images of our Saviour holding the world in His hand, and of the blessed Virgin. Beneath them were a crown and the fleur-de-lis, the golden lilies of France, all wrought upon white linen, with a silken fringe. There were inscribed upon it the words, JESUS ✠ MARIA. When Joan received the banner in her hands her rapture knew no bounds, and to the last she loved it with extreme attachment. She rode round the camp amid a storm of acclamations. She had just completed seventeen; of middle stature; her figure robust and agile, with black hair and handsome features,—not the Greek ideal beauty which sculpture has since bestowed upon her, but a bright face of peasant comeliness.[25] Her

The king permitted to accept her services.

Her banner and sword.

Her form and features.

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[23] The depositions at Poitiers are unhappily lost, and appear to have been so at the time of the Cause of Revision; all that is known of them is from the memory of those who were present. Joan upon her trial constantly refers to them.

[24] Quod in eâdem nihil invenerant fidei Catholicæ contrarium et quod, attentâ necessitate rex de eâdem se juvare poterit—Evidence of the Duke of Alençon, vol. iii. p. 93.

[25] Erat brevi quidem staturâ, rusticanâ facie et nigro capillo, et toto corpore prævalida—vol. iv., p. 523. "Competentis est elegantiæ, virilem sibi vindicat gestum".—*Letter of Perceval de Boulainvillers to the Duke of Milan, written 21st June,* 1429.

deportment on horseback and in arms was a wonder to see. Her voice was gentle and womanly.[26] She spoke little, but with what impressiveness, we have her own recorded words to tell. "It seems like a divine thing", wrote the young Counts of Laval shortly after, "to look upon her and to hear her".[27] She bore her harness, says the Duke of Alençon, as knightly as if she had done no other thing in all her life. The king put her at the head of the relieving force to march to Orleans. Her first act of command was to banish from the camp all women of evil life, and to make every soldier go to confession and communion. Think of it! Those old warriors of the Armagnacs, who but a few years before, in the sack of Soissons, had committed horrors of sacrilege which the pen almost refuses to write, became like little children in her hands. The past with all its guilt and unutterable misery was forgotten. With consciences purified—with hearts bathed anew in faith and hope—with faces radiant with anticipated triumph, they marched under the visible blessing of Heaven to combat in the noblest of causes.

She sets out with the relieving force for Orleans.

There is still extant in the archives of Brussels the transcript of a letter written by one who saw her at that time before the relief of Orleans, viz., the 12th April, 1429, and who relates her prophecy—that she would be wounded there, but not mortally—a prophecy exactly fulfilled. The French captains practised a deceit on Joan, and led her and the army to Orleans by Sologne, on the left bank, instead of, as she desired and commanded, right through the ranks of the English.

Dunois came forth from the city to meet her. He himself has described this first interview: "Are you", said she, "the Bastard of Orleans?" who answered that he was, and that he rejoiced at her coming. "Is it you", said she, "who have given the advice to come by this side and who have hindered me from going directly where Talbot and the English are? To which the deponent answered that others wiser than he had believed that counsel the surest. Then Joan replied: In the name of God the counsel of our Lord is surer and wiser than

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[26] Vocem mulieris habet ad instar gracilem—Letter of Perceval de Boulainvillers.

[27] In a letter to their mother: "et semble chose toute divine de son faict, et de la voir et de l'ouyr".

yours. You thought to deceive me, and you have deceived yourselves, for I bring to you the best succour that has been ever given to any city, since it is the succour of the King of Heaven. It does not come from me, it has been sent to you at the prayers of St. Louis and St. Charlemagne; God hath had pity on the town of Orleans. And the deponent says besides, that the winds, which till then had been contrary and hindered the transport of provisions, suddenly changed and became favourable. The boats immediately set out with full sail and arrived in spite the English guns. From this moment the deponent had of good hope, and besought Joan to enter into Orleans, where her presence was so much desired. From all these circumstances it appears to deponent that these things came from God rather than man".[28]

She rode by the side of Dunois into the city, and she was received by the people as an angel from Heaven. The attacks upon the English works commenced immediately.[29] The English fought resolutely as always, but the French were in such a state of exalted enthusiasm, that it was not in mortal valour to resist them. Joan herself never struck with the sword, but she rode foremost, banner in hand, into the ranks of the enemies. Afterwards upon her trial she told her simple secret: "I said to the soldiers, enter boldly among the English, and I myself entered boldly". Bastille after bastille of the besiegers was captured, and in ten days from the time when she set foot within the city, that siege which had lasted eight months was at an end. Talbot and Suffolk broke up their camp and retired to the north. She peremptorily forbade any pursuit. "This day", she said, "is Sunday; let us go and thank God"; and causing a great altar to be erected in the plain before the city, she had a Mass of thanksgiving offered for their deliverance in the sight of all the people. Till then Joan was known as La Pucelle, The Maid, but her name became then imperishably linked with the city she had saved, and she was thenceforth for all time the Maid of Orleans.

The siege is raised.

How prodigious was the effect of this blow, we may well conceive. Neither nation ascribed it to human arm; but, while the French exulted in the manifest help

[28] Evidence of Count Dunois, vol. iii. p. 6.

[29] An able and interesting account of the details of the siege and deliverance of Orleans will be found in Professor Creasy's Fifteen Decisive Battles of the World, p. 304.

of God, the English, in their hate and fear, called it witchcraft and the work of the Devil. "The courage of the soldiers was shaken", wrote the Duke of Bedford, "by lack of sadde beleeve (want of serious faith), and unlawful doubt they had of a disciple and limb of the fiend called the Pucelle, who used false enchantments and sorcery".[30]

The indecision of Charles.

But what is astounding is, that in this tide and flood of victory, Charles and his advisers returned once more to their timid councils. They wished not to hazard what they had won, and they sought to confine themselves to a defensive warfare on the Loire, which meant, in truth, to give the enemy time to recover from their panic, and to come back recruited in heart and strength. Joan spoke boldly what her voices told her was to be done. Until King Charles VII. had been crowned at Rheims, his title was but half consecrated in the eyes of his subjects. She told the king that they should march to Rheims for his coronation. Rheims was 150 miles from Orleans. The intermediate country was entirely in the hands of the enemy, bristling with strong places, and traversed by three deep rivers. Yet once more the fervour of the people's faith overpowered the prudence of the courtiers, and the expedition to Rheims set forth. It promised to occupy months of siege and battle, and it was like a long triumphal march. The Earl of Suffolk had thrown himself into Jargeau, the first town upon the line of way. It was at once stormed and captured. When Joan saw the Duke of Alençon hesitate to commence the assault, she said: "Ah, gentle duke, are you afraid?—do you not know that I have promised to your wife to bring you home sound and safe?"

The march to Rheims.

Capture of Jargeau.

Battle of Patay.

The English had still an army in the field under the command of Lord Talbot, and they met the French at Patay. But the time was signally reversed when 200 Englishmen could beat 400 Frenchmen. It was now, as Dunois said, 200 French who could put to flight 400 English. The English soldiers felt the omen of evil upon them. Their hearts sank and their arms were paralyzed when they saw the gleamingof that white panoply, and the waving of that banner, which was the presage of victory to France, of dismay and discomfiture to them. The English army were scattered at Patay, and the French advanced to

[30] Rymer's Fœdera, vol. x. p. 403.

Troyes, the capital of Champagne. Once more the cold fit seized the French leaders. How could they, without machines or siege artillery, take so strong a place? They seriously thought of breaking up and returning to Orleans. Joan implored of them to wait for three days. "We would gladly", said they, "wait six". "Six days!" said she; "I tell you we will be in the city to-morrow"; and the next morning the city capitulated without a blow. The road was now open to Rheims. They entered on the 14th of July, 1429, and on the following Sunday Charles was duly crowned by the Archbishop of Rheims according to the ancient rite, and anointed with the sacred oil which St. Remy had brought from Heaven 900 years before for the coronation of Clovis.

Capture of Troyes.

Coronation of Charles at Rheims, 15th July, 1429.

When the rite was finished, Joan flung herself before the king, and embraced his knees weeping: "O gentle king!" she said, "now is accomplished what I told you God would do; that I should raise the siege of Orleans, and lead you into your city of Rheims to receive your holy consecration, showing you are true king". She rejoiced beyond measure in the joy which she saw around her. At Crepy, on their way homeward, she said to the Archbishop of Rheims: "Behold a good people, nor have I anywhere seen any people rejoice so much at the return of so noble a king. Would I could be so happy when I finish my days, to be buried in this land". "O Joan", said the archbishop to her, "in what place have you a hope of dying!" "Where it pleases God", she said, "for of the place or hour I know no more than you, and would that it pleased God, my Creator, that I could now depart laying aside my arms, and returning to serve my father and mother in keeping their sheep with my sister and my brothers, who would much rejoice to see me".[31]

Was the mission of Joan finished at Rheims? We find it so stated in almost all histories; and a misreading of her conversation with the archbishop led even to the statement, that she had implored King Charles to permit her, now when her task was done, to return and keep her father's sheep. Yet, nothing has been proved more clearly from the answers of Joan herself upon her trial, than that she did not believe her mission to have then terminated. She was sent, she says, and says it again and again, to drive the last of the English out of France;

Was her mission then finished?

[31] Evidence of Dunois, vol. iii. p. 14.

and she averred that if she were once more in armour in the French camp, it would be one of the greatest blessings that could befall France. And again, a few days before her death, when urged to resume her woman's dress, she said, "when I shall have accomplished that for which I was sent from God, I will take the dress of a woman".[32]

Intrigues against her.

Yet, in one sense her mission *did* end at Rheims. The faith of the people still followed her, but her enemies, not the English, but those in the heart of the court of Charles, began to be too powerful for her. We may, indeed, conceive what a hoard of envy and malice was gathering in the hearts of those hardened politicians, at seeing themselves superseded by a peasant girl. They, accustomed to dark and tortuous ways, could not comprehend or coalesce with the divine simplicity of her designs and means. A successful intrigue was formed against her.[33] It was resolved to keep her still in the camp as a name and a figure, but to take from her all power, all voice in the direction of affairs. So accordingly it was done. The French in August besieged Paris, then in the hands of the English. The siege was undertaken contrary to her advice; she took part, nevertheless, in the assault with her accustomed fearlessness, and was wounded. The assault was repelled, but Joan rising from her wound, said that she was assured that if the assault were renewed they would win the city. In answer to that exhortation, they put her by force upon a horse, and sent her back to the camp while a retreat was sounded. And then they cast the entire responsibility of the failure upon her.

She is taken prisoner at Compiegne.

What pangs must that poor heart have suffered during that weary time, belied and discredited; burning with love of France, and made impotent to serve her! She still, however, fought as usual, and when the Burgundians laid siege to the town of Compiegne, on the Oise, she threw herself into it to defend it. That very day she headed a sally against the besiegers. But her followers retired, and she, who was ever in the front, was left alone. She was surrounded and captured by the

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[32] Quando ego fecero illud propter quod ego sum missa ex parte Die accipiam habitum muliebrem, vol. i. p. 394.

[33] "George de la Tremouille", says M. Quicherat, "endured the Pucelle, but it was in order to labour for the ruin of her influence; a work which he directed with infernal perfidy, making the odium of its execution fall as far as possible on his colleagues".

Bastard of Vendomme,[34] a knight in the service of John of Luxemburg. It was the 23rd of May, 1430, a little more than a year from the deliverance of Orleans.

Her habits while in arms.

Her ways and habits during the year she was in arms are attested by a multitude of witnesses. Dunois and the Duke of Alençon bear testimony to what they term her extraordinary talents for war,[35] and to her perfect fearlessness in action; but in all other things she was the most simple of creatures. She wept when she first saw men slain in battle, to think that they should have died without confession.[36] She wept at the abominable epithets which the English heaped upon her; but she was without a trace of vindictiveness. "Ah, Glacidas, Glacidas!" she said to Sir William Glasdale at Orleans, "you have called me foul names, but I have pity upon your soul and the souls of your men. Surrender to the King of Heaven!"[37] And she was once seen, resting the head of a wounded Englishman on her lap, comforting and consoling him.[38] In her diet she was abstemious in the extreme, rarely eating until evening, and then, for the most part, only of bread and water sometimes mixed with wine. In the field she slept in her armour, but when she came into a city, she always sought out some honourable matron, under whose protection she placed herself; and there is wonderful evidence of the atmosphere of purity which she diffused around her, her very presence banishing from men's hearts all evil thoughts and wishes.[39] Her conversation, when it was not of the war, was entirely of religion. She confessed often, and received communion twice in the week.[40] "And it was her custom", says Dunois, "at twilight every day, to retire to the church and make the bells be rung

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[34] Not Vendôme, as often written. Her captor was a simple knight, in no way connected with the blood of Bourbon.

[35] "Especially", says the latter, "in the management of artillery. She showed", he adds, "the skill of a leader of thirty years' experience".—Vol. iii. p. 110.

[36] Vol. iii. p. 106.

[37] Contrast this with the stern Amazon drawn by Schiller—see especially the scene with Montgomery, in which Joan is made to say that he might as well look for mercy from the lioness or spotted tigress, as beg his life from her.—Jungfrau Von Orleans, act ii. scene 7. Indeed, the whole play as a work of art is quite unworthy the great author of the Piccolomini.

[38] Vol. iii. p. 72.

[39] See the Evidence of Jean of Metz, vol. ii. p. 438, and of Dunois, vol. iii. p. 15.

[40] D'Alençon, vol. iii. p. 100.

for half an hour, and she gathered the mendicant religious who followed the king's army, and she put herself in prayer, and made them sing an antiphon of the blessed Mother of God".[41] From presumption, as from superstition, she was entirely free. When women brought her crosses and chaplets to bless, she said: "How can I bless them? your own blessing would be as good as mine".

Her anxiety for union among Frenchmen.

She ever yearned after the union of Frenchmen, and on the very day of the coronation at Rheims, she dictated a touching letter to the Duke of Burgundy, conjuring him to be no longer an enemy to his country, but to let the past be forgiven in Christian peace. But of negociations with the English she was supremely impatient. "I tell you", she often repeated, "there is no peace to be made with the English, except at point of lance".[42]

The English are resolved to obtain possession of her,

She was now a prisoner in the hands of John of Luxembourg, a vassal of the Duke of Burgundy. But from the moment of her capture, the English set their hearts upon obtaining possession of her. That deep pride of character which was perhaps a large element in their success had its darker expressions. It rendered them intolerant of the slightest defeat or check, and engendered towards any enemy who might inflict it upon them a hatred stopping short at no calumny and no cruelty. Their hatred of Joan was something wholly indescribable, and from the beginning they had spread the most abominable slanders concerning her. They were resolved upon her destruction,—not merely upon killing her, for that would avail little while her memory remained a beacon for France, but upon blasting her name and its influence, stamping upon her for ever the brand of evil, and extinguishing in infamy that light which had been of such disastrous omen to them. They designed to have her condemned by an ecclesiastical tribunal as a blasphemer and a sorceress. In their proceedings to effect this end two circumstances curiously characteristic of the nation appear; first, their accomplishing their purpose under colour and in form of strict law; and secondly, their using as their instruments natives of the country whose subjugation they sought.

and to have her tried for sorcery.

Pièrre Cauchon,

Their chief instrument in this case was Pierre Cauchon, Bishop of Beauvais. That he acted with deliberate iniquity it is by no means necessary for us to believe.

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[41] Dunois, vol. iii. p. 14.

[42] "Nisi buto lanceæ".

There are many contemporary testimonies highly favourable to him, and in the very brief of Pope Calixtus III., by which the process of revision was instituted, he is called *vir bonæ memoriæ*. But all his words and acts throughout this business show that his judgment was radically perverted by faction and ambition. He had been always a strong partizan of the Burgundians, had attained the high dignities of rector and conservator of the privileges of the University of Paris (the most Burgundian of corporations), and was held in great esteem by Philip, Duke of Burgundy, who bestowed upon him the bishopric of Beauvais. When Beauvais fell into the hands of Charles VII., he was driven from the possession of his see, and took refuge in England with the Cardinal of Winchester (the Cardinal Beaufort of Shakespeare), who took him wholly under his patronage. He became a devoted adherent of the house of Lancaster, and the English promised him the archbishopric of Rouen.[43] Thus all his feelings, his resentment for the past, his hopes for the future, were bound up with the maintenance of the English power in France, and he naturally regarded with abhorrence whatsoever threatened that power. But not only were the feelings of the Bishop enlisted against Joan; that sentiment was strongly shared by all the ecclesiastics in the English or Bungundian interest, and, foremost among them, by the University of Paris. The party spirit which divided the nation ran high, as we may conceive, among the clergy too. And when the College at Poitiers absolved her from the taint of sorcery, and declared that Charles might lawfully use her services, the opposite party were all the more loud in pronouncing her a witch: to this their position forced them; for if she were sent from God, what was to be thought of their cause? So that not alone with the English rulers and soldiers, but with a large body of French ecclesiastics, and amongst them many learned and able men, the belief in the sorcery of Joan acquired almost the strength of a first principle. We should bear this always in mind in judging of the tragedy that followed.

Bishop of Beauvais.

His strong partizan feelings.

The news of the capture of Joan had hardly time to reach Paris, when the vicar in that city of the inquisitor

Requisitions for

[43] See this promise recorded in the proceedings of the Privy Council of England, published by Sir Harris Nicolas, vol. iv. p. 10.

the surrender of Joan.

of France, at the instance of the University, despatched a letter to the Duke of Burgundy (26th May, 1430), requiring Joan to be delivered up, that she might be brought to Paris and tried there by the Church. This summons never was proceeded on, for the English were reluctant that she should be tried in Paris, which, though deeply Burgundian as we have seen, was not so entirely under their control as their provinces in the north. They sought a pretext for getting her into their own hands, and in this a singular accident favoured them. It so happened that the place where Joan was taken, outside Compiegne, was just on the borders of the diocese of Beauvais. This circumstance was made the foundation for a claim by the bishop, who was then at Rouen, of ecclesiastical jurisdiction over her. He sent a requisition to the Duke of Burgundy and John of Luxembourg, demanding that she should be delivered up to him to be tried. This requisition was aided by letters from the University of Paris, couched in terms which vividly express the terror that she inspired. After speaking of the possibility of her escape being effected, they go on to say: "For such great damage to holy faith, such enormous peril and loss for the whole state of the kingdom, have not happened in the memory of man, as would happen if she escaped by such accursed ways without due reparation", and they say it would be still worse if she were liberated "for money or ransom".[44]

She is demanded on the part of the King of England as suzerain,

But John of Luxembourg by no means thought of parting with his prisoner simply upon these requisitions. In those days an important prisoner of war was a very valuable piece of booty, and a high ransom might naturally be expected for Joan. So another machinery was resorted to. According to the feudal jurisprudence of France, the king, as chief suzerain, was entitled to have the prisoners of his vassals delivered up to him upon paying to the captor the value of their ransom according to a graduated scale. The highest ransom was ten thousand francs. Now as Henry VI. of England was also King of France by the treaty of Troyes, a formal demand of the prisoner was made in his name grounded on this law. And to avoid all cavil, the highest ransom was offered. "And although the capture of that woman is not like that of a king or prince or other person of great es-

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[44] Vol. i. pp. 9, 11.

tate, whom the king would be entitled to have from any vassal for the price of 10,000 francs, according to the custom of France, yet our Lord the King offers that sum".[45] And, in addition, an annuity for life was promised to the knight who actually took her.

The negociations for her surrender were spread over months, but at length she was formally delivered into the hands of the officers of the King of England. While she was with the Burgundians, she seems to have been treated as a prisoner of war, with honour and humanity, and from the wife and aunt of John of Luxembourg she received such kindness, that she afterwards declared that if human influence could have prevailed upon her to change her male garb, she would have done it at the exhortation of those ladies.[46] Yet it was during that period that she was guilty of the first formal disobedience to her voices in a desperate attempt to effect her escape. In her extreme dread of falling into the hands of the English, she sprang from the top of a high tower at the Castle of Beaurevoir, contrary to their command. She said she could not help it.[47] She fell dizzy from the leap, but, strange to say, unhurt, and was carried back into the castle insensible.

and is at length delivered up.

Her leap from the tower of Beaurevoir.

What she feared so much had now come to pass, and she was in very different hands from those of the ladies of Beaurevoir. They brought her to Rouen in chains, and cast her into a cell, where she was pinioned to the wall by iron fetters on her hands and feet, and three English men-at-arms were set to guard her day and night.

In the meantime the preparations for her trial were slowly proceeding. Commissioners were sent into her own country to take depositions as to her early life and habits. These depositions were evidently too favourable to her. Some idle rumours were gathered, such as that she had been at one time a servant at an inn and there learned the management of horses and the use of arms—a statement which, though shown to be without foundation, was afterwards reproduced by Monstrelet, and copied from him by Hume; some simple calumnies, such as a gross charge in reference to De Baudricourt; some vague accusations of superstition in connection with the

Preparations for her trial.

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[45] Vol. i. p. 14. [46] Procès, vol. i. p. 95.

[47] This simple expression for a strong impulse was afterwards made one of the grounds of charge against her. "In quo male sentire videtur de libertate humani arbitrii et incidere in errorem illorum qui", etc., etc., Procès, vol. i. p. 260.

fairy tree. But all these were felt to be worthless, and the depositions were suppressed in the record. Joan was indicted and condemned out of her own lips.

Assembly of her enemies in Rouen.

The Cardinal of Winchester, the Duke of Bedford, and the Earl of Warwick, the tutor of the young king, assembled in Rouen for the trial. Their all-powerful influence was felt at every stage, but of their presence the published proceedings give no trace. There came also from Paris many doctors of high repute, but all strong partizans. The see of Rouen was then vacant, but territorial jurisdiction for the trial was obtained, though with some difficulty, from the vicar-capitular and chapter of Rouen. When the first public session was held in the Royal Chapel of the Castle of Rouen, on the 21st of February, 1431, the bishop sat with no less than forty-two assessors, viz., fifteen doctors of theology, five doctors of civil and canon law, seven bachelors in theology, eleven bachelors in canon law, and four licentiates in civil law. When the court sat, a formal citation was delivered to the apparitor to be served upon Joan in her prison. In his return to this writ the apparitor relates two requests which she made at the time of citation, first, that ecclesiastics of the side of France as well as those of the side of England might sit upon her trial, and secondly, that she might be permitted to hear Mass. The first request was passed over in silence; the second was refused, "in consideration of the crimes of which she is accused and the deformity of the garb in which she perseveres". She was then brought before the tribunal and an oath tendered to her, to answer truly to whatsoever should be demanded of her. But she peremptorily refused to take the oath in that form. She would answer fully, she said, as to her own acts; but as to her revelations from God, she had confided them to no one but Charles, "whom she calls her king"; nor would she to any other if her head were to be cut off. She ultimately took the oath to answer concerning matters of faith, reserving to herself the right not to answer as to the secrets of her revelations. She was then minutely examined before the full court of assessors for five successive days. At the end of that period the bishop resolved, for reasons which we may divine, that her further examination should be conducted in the prison in the presence of four or five persons selected by himself. She was accordingly for six days further, and generally twice a day, sifted in the

Her two requests.

She is examined in public

and in the prison.

prison by these special examiners, astute and practised men. It is hard to describe what effect the perusal of these examinations leaves upon the mind, or what an impression it gives of her uprightness and good sense, her simplicity, her piety and humility, and her unshaken faith in the reality of her own inspirations. "I believe", she said, "firmly, and as firmly as I believe the Christian faith, and that God redeemed us from the pains of Hell, that my voices came from God and by His ordinance".[48] Her voices, she said, had been with her from the beginning, and she had always obeyed them except when she leaped from the tower of Beaurevoir. They were still daily communing with her in her cell, and telling her to answer boldly to her questioners. Her accusers put to her the mystery hidden from man, and asked her if she was in a state of grace. "If I am", she answered, "may God keep me in it; if I am not, may God put me in it.[49] I would grieve more than for the whole world, if I knew that I were not". Yet she added, that she did not believe that, if she were in mortal sin, St. Catherine and St. Margaret would come to her. She was asked why, if she were not in sin, she confessed so often. "One can never", she said, "cleanse one's conscience too much". She was asked if St. Catherine and St. Margaret hated the English. "They hate what God hates, and love what God loves". Does God then hate the English? "Of the love or hatred which God bears to the English, or what He means to do to their souls, I know nothing; but I know that they will all be driven forth of the realm of France, except those who will die there". She was accused of having prevented peace. No, she said; "I did all in my power to make peace with the Duke of Burgundy; but as to the English, the peace to be made with them, is, that they go back to their own country of England".[50] She was asked whether she had placed more confidence in her banner or her sword: "My trust", she said, "was neither in sword nor banner, but

Her answers.

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[48] Vol. i. p. 62.

[49] Interrogata an sciat quod ipsa sit in gratiâ Dei, respondit "Si ego non sim Deus ponat me, et si ego sim, Deus me teneat in illâ. Ego essem magis dolens de toto mundo, si ego scirem me non esse in gratiâ Dei".

[50] "Quantum ad ducem Burgundiæ ipsa requisivit eum per litteras et suos ambaxiatores, quod esset pax inter regem suum et dictum ducem, quantum vero ad Anglicos, pax quam oportet ibi esse est quod vadant ad patriam suam in Angliâ".—Vol. i. p. 233.

was wholly in God". She was asked if she had not sinned in leaving her father and mother against their wish. She said that if she had offended therein, they had forgiven her; that in all things else she had obeyed them, but that in this she was bound to obey God rather than them, and if she had a hundred fathers and mothers, and were the daughter of a king, she would have done likewise.

Her story of the angel.

Yet (for the truth must be told) it is evident that on one point Joan was guilty of prevarication. She had, as we said, refused at the beginning to take the oath to answer simply everything which was asked of her; for she apprehended that questions might be put to her which she could not lawfully answer; and this determination she persisted in throughout, although at the commencement of every examination the same scene was repeated of extreme importunity on the part of her examiners to induce her to take the oath without restriction. Now, amongst other subjects upon which she was closely pressed, was the sign which she had given to Charles VII., by which he recognized her divine mission. That sign consisted, as we have seen, of the revelation to him of his doubts as to his legitimacy, and of his secret prayer. With Joan's feelings towards the king, she would sooner have died than publish such a thing to the world. Accordingly for many days she met the question with a simple refusal to answer—"You will not", she said, "extract that from my lips".[51] Her examiners having still returned to it the more eagerly on that account, she at last cried out, "Would you wish me to perjure myself?"[52] and immediately after, as if seeing there was no escape, she commenced a story about an angel having brought from Heaven a crown of gold and jewels, and placed it on the king's head in the hall of Chinon. An endeavour has been made to explain this as an allegory; and that she herself was the angel who brought to the king the crown of France. Surely it is simpler to say with Joan herself afterwards on the point of death,[53] that it was a fiction in which, tortured as she was, she took refuge—a fiction, not

[51] "Interrogata quale signum dedit regi suo quod ipsa veniebat ex parte Dei respondit: Ego semper vobis respondi quod non mihi extrahetis illud ab ore".—Vol. i. p. 91.

[52] Essetis vos contenti quod ego incurrerem perjurium.—Vol. i. p. 139.

[53] To the Friar Martin L'Advenu—"Dixit et confessa fuit quod, quidquid dixisset et se jactasset de dicto angelo, nullus tamen fuerat angelus qui dictam coronam apportasset".—Vol. i. p. 479.

a perjury, for it was expressly excluded from the compass of her oath.

The great point upon which she was urged was her assumption of male attire contrary to a canon of the early Church; but this she said she had done, because she was so commanded from on high.[54] On one matter they were more successful in ensnaring her—that of submission to the Church. They asked her would she submit the truth of her visions to the decision of the Church. She said she referred herself to God and His holy angels. They told her it was not to the Church triumphant, but to the Church militant, that she was required to submit. It is evident that she construed their meaning to be, that she should submit her revelations to them, her judges, by whom she knew she was prejudged, and she refused to make the required submission. Yet, even in that her deep sense of faith pointed out at last the true solution; and she said when she was brought out to receive sentence: "I appeal to God and to our Lord the Pope". "We cannot go so far as to seek the Pope", cried the Bishop of Beauvais; "every ordinary is judge in his own diocese".[55] Her voices, she said, promised her salvation, but conditionally upon her preserving her virginity of body and soul. They also promised her deliverance from her enemies, but in what way she knew not; but for the most part, they said, it would be through a great victory; and they said to her: "Take all patiently, neither be solicitous concerning thy martyrdom; thou shalt come finally into the kingdom of Paradise. And she called it martyrdom for the pain and adversity which she endures in the prison; and she knows not whether she shall suffer yet greater pains, but she commits herself to God".[56]

She is required to submit to the Church.

Her appeal to the Pope.

[54] She prayed fervently, she said, for light as to the relinquishment of this dress, and she gives the words of her prayer: "Tres doulx Dieu en l' onneur de vostre sante passion, je vous requier, se vous me aimés que vous me revelés que je doy respondre a ces gens d' Eglise. Je sçay bein quant a l' abit le commandement comme je l' ay prins. Mais je ne scay point par quelle maniere je doy le laisser. Pour ce plaise vous a moy l' enseigner".—*Procès*, vol. i. p. 279.

[55] Interrogata utrum velit revocare omnia dicta et facta sua quæ sunt reprobata per clericos: respondet: "Ego me refero Deo, et Domino nostro Papæ"—et fuit sibi dictum quod hoc non sufficiebat et quod non poterat fieri quod iretur quæsitum Dominum nostrum Papam ita remote; etiam quod ordinarii erant judices quilibet in sua diœcesi.—Vol. i. p. 445. The disallowing of this appeal seems to have been the grossest piece of illegality connected with the trial.

[56] Et ut plurimum voces ei dixerunt quod ipsa liberabitur per mag-

Out of her answers were culled carefully such as were conceived to tell against her; and these were digested into twelve articles, which were sent for the opinion of the University of Paris. The opinion of that body, whose sentiments we have seen, could not be long doubtful. They condemned the propositions sent to them as blasphemous and heretical; and soon after the answer came back, Joan was formally condemned in a full assembly of the assessors, and on the morrow of Pentecost, in the year 1431, was led out to receive the doom of a sorceress and an apostate.

Articles sent to Paris.

Her condemnation.

In this dreadful trial she seems to have been abandoned to her own strength. She had faced death a hundred times in the field with perfect calmness, but this chalice was of another kind. That agony of fear of death, which sometimes assails the finest natures, overcame her, and she shrank from the faggot and the fierce flame. "Give me", she said, "I will sign a retractation". So a paper was put into her hands to sign, by which she declared herself misled by her voices, and renounced the use of her male attire. She was sentenced, as a merciful commutation, to perpetual imprisonment, with bread and water. This sentence she ought legally to have undergone in the ecclesiastical prison; but the Bishop of Beauvais gave her up again to the English, who led her back to her old cell.

Her retractation and sentence.

And now we may ask one question. A full twelvemonth had elapsed since she had been taken prisoner: what did her king, Charles VII., do for her during that time?—did he make a single effort to save her who had given him back his crown and kingdom? He had the wealth of cities which she had won for him—he might have offered to ransom her, so long at least as she was in Burgundian hands. He had many noble captives, prisoners of her victories; he might have offered them in exchange, or justly threatened their lives if a hair of her head were injured. Or if everything else failed, ought he not to have put himself at the head of the chivalry of France, and marched to rescue her or perish? History has to relate, beyond all recorded ingratitude, that he made no sign, did not even speak one word on her

Ingratitude of Charles VII.

nam victoriam: et postea dicunt sibi ipsæ voces, "Capias totum gratanter: non cures de martyrio tuo: tu venies finaliter in regnum Paradisi . . . Et vocat illud martyrium pro pœna et adversitate quam patitur in carcere, et nescit utrum majorem pœnam patietur sed de hoc se refert Deo".—*Procès*, vol. i. p. 135.

behalf. On the contrary, there is the clearest evidence that the coterie around him were filled with base satisfaction at getting rid of her, and probably looked to her death almost as eagerly as the English. As for Charles, his feeling was not *that*, but was simple indifference. He was enslaved to ignoble pleasure; and what can be more dead to gratitude or duty than the heart of a voluptuary? It was of Agnes Sorel that he thought, and not of the pure maiden Joan. Yet she never dreamed of reproaching him; throughout her trial she remained full of loyalty, as enthusiastic and tender as when she knelt at his feet at Chinon or at Rheims. In the very sermon which was preached to her at her condemnation, she bore in silence all that was said against herself, but when the preacher called her king a heretic and a schismatic, she arose and reprimanded him, and said that her king was the noblest of Christians and the truest to the faith and to the Church.

Resolution of the English to destroy her.

She was now condemed to perpetual imprisonment; but the English never meant to be so baulked of their prey. What care they had of her we can judge from one circumstance. During the course of her trial, she became seriously ill. The Earl of Warwick summoned the best physician in Rouen, and told him to attend her well. "For", said he, "my king has bought her dear and holds her dear, and would not on any account that she died a natural death, or otherwise than by the hands of justice at the stake".[57] What plot was laid to bring to pass the tragedy which ensued, will never be fully known. One witness afterwards said, that her woman's clothes which she had adopted in obedience to her sentence, were taken away from her during the night and her male attire alone left beside her, so that she had no choice but to assume it. And this is highly credible, for having at her retractation finally abjured the garb of a man, how else, except by the order of her keepers, did she come by it? That she was found in her dungeon a few days after in her male dress is unquestionable, and this was seized on as conclusive evidence of her obstinacy and relapse. It must, however, be added, that she plainly repented of and recalled her abjuration, and when the bishop and some of the offi-

She repents of her retractation

[57] "Quia pro nullo rex volebat quod sua morte naturali moreretur, rex enim eam habebat caram, et care emerat, nec volebat quod obiret nisi cum justitia et quod esset combusta".—Deposition of the physician De Camera, vol. iii. p. 49.

cials visited her in prison, she declared openly that she had sinned in denying her revelations, and asserted anew that her voices were from God. And then the bishop told the Earl of Warwick to be of good cheer, for that all was finished. This was upon Sunday. On Tuesday the Bishop of Beauvais summoned the judges once more, and on Wednesday morning a good friar, Martin l'Advenu, was sent to hear her confession, and to announce to her that she was that day to be led out and burned. She was overcome with anguish, not so much at the thought of death, as of the dreadful death she was to die. But she recovered herself, made her confession humbly, and implored to receive the Sacrament, which was not denied her. When she was led forth, weeping, she once more beheld her judges sitting cold and stern. She saw the pitying faces of the people, and the fierce eyes of the English soldiery as they stood in arms around the pile where she was to suffer. "Ah, Bishop, Bishop", said she to the Bishop of Beauvais, "I die through you; if you had put me in the prison of the Church, and given me fit keepers, this would not have befallen me". When her sentence was about to be read, she fell on her knees, invoking God and the Blessed Virgin, St. Michael, St. Catherine, and St. Margaret, and she asked of all to pray for her; and from her judges, from the bishop, and all, she implored that they would say a Mass for her soul. Every one was melted to tears, except some of the brutal soldiery, who cried out: "Come, priests, make haste! do you mean to keep us here till dinner time?" Her sentence was then read, and she was handed over to the executioner. She asked for a cross, and a soldier breaking a staff in two, made a rude cross and gave it to her. Such as it was, she pressed it to her bosom, but she implored that a crucifix should be brought, that it might be held before her eyes when she was dying. There was a high scaffold erected and the faggots placed on the top, that her death might be visible to all, and that being once lit from below, it might be out of the power of the executioner to abridge her torture. "Oh, Rouen, Rouen!" she cried, "am I then here to die! I fear that thou wilt suffer through my death". This, then, was the deliverance which her voices had promised her. Her confessor ascended the scaffold with her, comforting her and exhorting her. When she was bound to the stake, and the fire applied below, she uttered a cry; but still, thoughtful for others rather than herself,

and is led out for final sentence.

Her death.

she implored of her confessor, whose zeal made him still remain near her, to go down, as he might be in danger.[58] She then said: "Whether I have done well or ill, my king is free from blame".

When the flames first touched her she shuddered, and asked for holy water; but as they gathered round her, she cried out, "My voices have not deceived me—my voices were from God".[59] From that time forth she uttered no word except the name of that Saviour which she had once inscribed upon her banner of victory, and with that holy name upon her lips she expired.

Her work was not the less accomplished. She said she had come to drive the English forth from France—and she did so. Their power continued to dwindle day by day. She said boldly on her trial that before seven years would pass, the English would receive a greater blow than the fall of Orleans; and in six years after that time King Charles entered Paris.

It would be a matter of interest, if space permitted, to trace in some degree the fate which her memory has undergone; how it was long obscured and defaced by forgetfulness and calumny; to say something of that drama which reflects so faithfully the passions of her national enemies, and which bears unworthily the name of Shakespeare; something also of that crowning disgrace to France—that composition where profanity vies with ribald indecency, and which bears most worthily the name of Voltaire. That work was worthy of the eighteenth century and its patriarch; but the nineteenth has other thoughts. France has returned to do homage to her heroine. Those whose principles lead them to deny any miraculous intervention in human affairs, yet place her in the first rank amongst wondrous human creatures; and we may say that almost every inquirer who has combined high intelligence with faith, has come to avow himself a believer in the truth of her divine mission. Where the Church has not pronounced, each one is of course left to his private judgment upon the evidence. We may, if it so seems to us, conclude that all this wonder—this undeniable history of an unlettered child, who in her obscure hamlet, not only declares herself commis-

[58] Dep. de Martin l'Advenu, t. iii. p. 169.

[59] Usque ad finem vitæ suæ manutenuit et asseruit quod voces quas habuerat erant a Deo . . . nec credebat per easdem voces fuisse deceptam.—Dep. de Martin l'Advenu, t. iii. p. 176.

sioned from on high to deliver her country, but from the beginning, details with luminous precision the means by which that deliverance was to be effected; who in the accomplishment of her task, was enabled at once to recognize those whom she had never seen, and to reveal secrets known to no mortal; whose prophecies of future events are attested by evidence which defies doubt; and who in the command of armies showed the skill of a captain of thirty years' experience—that it is all explicable upon natural principles of enthusiasm and delusion. We may, if we are of the class that can repose contentedly in words and abstractions instead of realities, name her the impersonation of the soul of France, and even (*her* the most devoted to her king and to his nobles!) the herald of the triumph of democracy and of the rising of the Gaul against the Frank and Norman. We may recur for an explanation to the modern miracles of mesmerism and spiritualism. Or we may, upon the whole, deem it the simpler solution to say, that in a great crisis in which the whole future of the balanced commonwealth of Christian Europe, and with it the peace and freedom of the Church, were imperilled, the Arm which had of old sent forth a shepherd boy for the salvation of Israel, was not shortened, and once more raised up the weak ones of this world to confound the strong. If Joan was not, as she averred, sent from God to save her perishing country, history has no such marvel and no such problem.

JOHN O'HAGAN.

ART. II.—*The Genius of Alcibiades.*

Alcibiades underrated in modern times.

HAVING been led by the study of the period in which Alcibiades lived, to the belief that modern writers have scarcely done justice to the importance of the part played by that extraordinary man in Grecian, and particularly in Athenian, history, we propose in this paper to endeavour to form as exact an appreciation as the existing sources of our information will permit, of the characteristics of his genius, and of the mode in which it developed and exhibited itself.

Niebuhr[1] has remarked that in the view of the ancients,

[1] Lectures on Ancient History (Schmitz), ii. 98.

Alcibiades was one of those demon-like beings who have power to change the destinies of whole cities and nations. Thucydides, that calmest and ablest of historians, who was probably personally acquainted with Alcibiades, but at any rate must have often heard him speak in the public assembly, bears in many passages of his history ample testimony to the marvellous power of his character. Thus in his sixth book (ch. 15), he distinctly attributes the downfall of Athens to the fact of their having withdrawn the command of their forces from the hands of Alcibiades. He says: "And although he had as a public man most admirably conducted the military operations, yet his personal habits and manner of life produced in them so much irritation and dislike, that they entrusted the command to others, and so in no long space of time brought ruin on the city". Again, the historian represents Alcibiades as the prime mover in the Sicilian expedition, which he undoubtedly regarded (ii. 65, vi. 31, 86, vii. 42) as no Quixotic enterprise, but as a scheme perfectly feasible; he also records the vigour and uniform success which characterized the early operations of the expedition during the brief period that they were presided over by Alcibiades. It is tolerably evident, therefore, that in the opinion of Thucydides that expedition also was ruined by the recall of Alcibiades, and might have succeeded, had he been allowed to conduct it. Aristophanes, in his play of the *Frogs*, which was exhibited in the year 406, that is shortly after Alcibiades had been superseded in the command of the fleet at Samos, makes Dionysus inquire of Æschylus and Euripides, what is their opinion respecting Alcibiades. Euripides, whom it is throughout the object of the dramatist to exhibit in a contemptible light, replies in a pompous strain, that he "hates a citizen who is slow to serve his country, but quick to benefit himself", etc. Æschylus, on the other hand, on being appealed to, replies in two fine oracular lines, the purport of which is—

His character as described by ancient writers: 1. by Thucydides;

2. by Aristophanes.

'Twere best to breed no lion in your state;
But if you do, you should consult his humours.

Now as, in the amusing trial of skill between Æschylus and Euripides, which takes place before Dionysus, the former is always the conqueror, and at last is formally adjudged as such by the god, and released from Hades accordingly, nothing can be clearer than that Aristophanes,

whose soundness of judgment and practical sense hines out in every page of his plays no less than his literary ability, was himself of opinion, and wished to instil that opinion into the Athenians, that, in spite of the heavy misdeeds of Alcibiades in times past, yet, for the sake of his lion-like powers, it was their interest to "consult his humours", and not, through their irritation at his personal habits, thwart him and set him aside when disposed to exert himself on their behalf. The like strain of thought is indicated by the passage in the Aves (l. 145), where Euelpides, in reply to the suggestion of the Hoopoo that there is such a blessed city as he is looking for, one uncursed by politics and law-suits, "*by the Red Sea*", replies—

> *διμοι, μηδαμῶς*
> *ἡμῖν γε παρὰ θάλατταν, ἵν' 'ανακύψεται*
> *κλητῆρ' ἄγουσ' ἕωθεν ἡ Σαλαμινία.*

The allusion here to the appearance of the Salaminian trireme at Catana, bearing the summons to Alcibiades to return and stand his trial, and the oblique censure cast on that proceeding by the dramatist, are too evident to require dwelling upon.

The judgment then of Aristophanes and Thucydides, both contemporaries—both eminently competent witnesses—may be quoted as testifying, first, to the extraordinary ability of Alcibiades as a statesman and as a general; secondly, to the folly of his countrymen in voluntarily depriving themselves of his services. We have drawn out the proof of this point at some length, because we shall require it presently when we review the judgments passed on Alcibiades by modern writers.

Testimony of the orators: The testimony of the orators, whether for or against Alcibiades, cannot pass for much. The most conscientious advocate, even in modern times, puts the worst or the best appearance on any given set of facts, according to the terms on which he has taken his brief, and it could not be expected that Athenian advocates would be found more scrupulous. The orators who mention Alcibiades are, Lysias, Isocrates, Andocides, and Demosthenes. Lysias eulogizes Alcibiades in the speech, "*Pro bonis Aristophanis*"; but in that against his son (*In Alcibiadem*, p. 142), he goes so far in the opposite direction as even to deny him more than average ability. Isocrates, in the oration *De Bigis*, written for the younger Alcibiades as a reply to the oration of Lysias just mentioned, takes occasion to enumerate all the splendid exploits of his father.

of Lysias, of Isocrates,

This he might do as an advocate merely; but in the *Busiris* (§ 5), an oration composed for the schools, not for the law-courts, Isocrates incidentally expresses an opinion to which more weight may be attached. In opposition to the sophist Polycrates he maintains (we quote the passage from *Müller's Grecian Literature*, p. 508), that the fact of Alcibiades having been educated by Socrates redounded to the latter's credit rather than to his disparagement, seeing that Alcibiades had "so far excelled all other men". The speech of Andocides against Alcibiades is, according to Müller, unquestionably spurious. Demosthenes, as might be expected from his more commanding intellect, gives a more independent, and therefore more valuable, opinion. In the oration against Meidias (p. 561), he refers to the history of Alcibiades as of a man who had performed signal service to his country, as of a great general and a consummate orator. But when he goes on to say, that in spite of all this, the Athenians had justly discarded him on account of the intolerable ὕβρις, or insolent pride, of his private character, we are not bound to regard this as his real opinion, but only as a statement accommodated to the requirements of his argument and the feelings of his hearers. He is charging Meidias with this unpardonable offence of ὕβρις, and the line of his reasoning is, "If your forefathers refused to pardon this crime in Alcibiades, counterbalanced as it was in him by eminent services to the state, much more should you refuse to pardon it in Meidias, who can plead no public services whatever". In the Ἐρωτικὸς λογὸς, p. 1414, among other instances of statesmen and generals benefited by the intercourse and instruction of philosophers, Demosthenes adduces the case of Alcibiades, who, though naturally far less disposed to virtue than Pericles, was yet materially improved by the teaching of *Socrates*. **of Demosthenes.**

The connection of Alcibiades with the illustrious man just mentioned, will be discussed further on. Among the other contemporary philosophers, Plato, though in no less than four of his dialogues Alcibiades holds a prominent place, does not appear to have felt much interest in him. Plato was a professional philosopher—a thinker *par excellence;*—extraordinary as was his intellect, he does not seem to have been a man of much *character*. Men of action—men formed to influence and rule their fellows—he did not perhaps entirely understand, and therefore could not adequately pourtray. We find in the dialogue **Testimony of Plato,**

called the first Alcibiades, a confirmation of the account given by Thucydides (vi. 90) of the schemes of wide-reaching ambition which our hero cherished in his youth. In the Protagoras, Alcibiades mixes occasionally in the conversation, but chiefly in the defiant spirit of a partisan who backs his own champion against all comers; a mode of representing him which illustrates so far the description of Plutarch, who says that his ruling passion was the ambition to contend and overcome. In the second dialogue bearing his name, Alcibiades is a mere lay figure, serving to introduce the Socratic theory of prayer. In the Symposium, Alcibiades comes into the house of Agathon drunk—a device of the writer in order to introduce naturally that extraordinary speech, in which, at his own expense, Alcibiades dilates on the moral purity and self-command of Socrates. But in all this there is but little indication that Plato felt that he was speaking of one of the most remarkable characters of his own or any other age. The name of Alcibiades serves to hang a theory or a disquisition upon, like that of Crito, or Euthydemus, or Agathon, and that is all. There is a little more characterization in the first Alcibiades than in the other dialogues, but this is probably derived from actual recollection of the sentiments entertained by Socrates towards his pupil.

of Xenophon. The only remaining contemporary writer is Xenophon. This author comes before us in a twofold character, as philosopher and historian. What he says of Alcibiades in the former character, we shall have occasion to notice when we come to consider the relations between him and Socrates. As a historian, Xenophon (*Hellenica*, i.) relates without comment the military career of Alcibiades between the years 411 and 406. We need not feel very desirous that he had been more explicit. He had neither the sagacious insight nor the sublime impartiality of Thucydides; he regards actions as mere external facts, rather than, with Thucydides, as the manifestation and illustration of the inner life of the agent; hence he is a good witness to matters of fact, and little more.

Testimony of later writers: Plutarch, The testimony of later writers is of course less valuable, but it all points to the same conclusion—the high estimate formed by the ancients generally of the genius of Alcibiades. The life by Plutarch is full of anecdotes handed down by literary tradition, many of which are doubtless no more to be depended upon than the current story, which Cicero (*Ep. ad. Att.*, vi. 1) records only to explode,

that Alcibiades threw into the sea Eupolis the comedian during the voyage to Sicily, although, as Cicero observes, Eratosthenes speaks of Eupolis as being in the land of the living several years later. One or two of these anecdotes, however, which bear internal marks of probability, will be noticed presently.

Cornelius Nepos seems to have been much impressed by the character of Alcibiades; he says of him, "in hoc natura, quid efficere possit, videtur experta". He refers to the eulogies passed on him by Theopompus and Timæus, writers who were notoriously "maledicentissimi", but who are both eloquent in his praise. Quoting from them, he describes the wonderful versatility of his character; how at Athens he was foremost in all the functions of an orator and a politician; how at Thebes he excelled the Thebans themselves in the amount of bodily toil which he would undergo, and the muscular strength which he exhibited; how at Sparta he was more severely abstemious than the Spartans; in Thrace drank harder than the drunken Thracians; and in Persia outran the very satraps in luxury. **and Cornelius Nepos.**

When we pass on to modern times, and get beyond the uncritical epoch in which scholars were contented to collect without sifting the testimonies of the ancients, we find, as Niebuhr remarks, an inclination gradually arising to depreciate Alcibiades. This was probably owing to the intense admiration felt by scholars for the Athenian people and institutions, which would lead them to pass no favourable judgment on the man who was constantly at variance with the great majority of his countrymen, and who, when it suited his purpose, set those institutions at nought. Mr. Mitford, however, who wrote the history of Greece on English Tory principles at the time of the French Revolution, had no love for the Athenian democracy, and hence has no motive for depreciating Alcibiades. The account given in these volumes of his career and character, is impartially weighed and eloquently expressed; and we unhesitatingly prefer it, both as more consistent and probable in itself, and as better borne out by the evidence, to the picture drawn by Mr. Grote. **Tendency in modern times to a tone of depreciation.**

Mr. Grote's extensive and important work on the History of Ancient Greece, merits all the praise to which great learning and critical power, set off by a correct and flowing style, entitle a historian. But that the glass through which he presents Greece and her worthies to our view, is wholly uncoloured by prejudice or miscon- **Mr. Grote's view**

ception, we cannot admit. The English "philosophical Radical" is often apparent under the critic's mantle, just as the old-fashioned English Tory meets us in every page of Mitford. The acts of the Athenian democracy are by Mr. Grote always placed in the fairest possible light;—when good, he "gilds refined gold"; when questionable, he leans to the side of commendation; when bad, he is inexhaustibly ingenious in palliation. The execution of Socrates is traced to a pardonable confusion of ideas in the minds of the sovereign multitude between the sage and the sophists; the sentence passed on the eight generals after Arginusæ, though condemned, is ingeniously shown (and we frankly admit that Mr. Grote makes a strong case) to have been natural under the circumstances, and even to have partly originated in humane and laudable feelings:—how, then, can we expect that Alcibiades, who comes so often into collision with the democracy, will meet with much sympathy from Mr. Grote? "It was not likely", we are told, "that either self-restraint or regard for the welfare of others, would ever acquire development" in his mind. Now, we think that the tenor of the last seven years of the life of Alcibiades is quite inconsistent with this assertion. When the army at Samos wished to abandon the seat of war and sail straight to Athens in order to put down the oligarchy, and were restrained by the single voice of Alcibiades, Thucydides thus writes (viii. 86):—"And it was then first, and in a degree surpassed by none, that Alcibiades appeared in the light of a benefactor of the city. . . . No other man at that crisis would have been able to restrain the multitude; but he both made them abandon the proposed expedition, and in stern language of rebuke put down those who were stirring up ill feeling against the envoys of the oligarchy". Again, his practice of conforming his own habits to the mode of life in vogue in the country where he might be sojourning, as when at Sparta he outdid the Spartans themselves in the rigour of his bodily discipline and the plainness of his diet (Plutarch *in vitâ*), certainly does not bespeak him wanting in the power of self-restraint when the occasion seemed to him to call for it. Indeed, without a considerable share of that quality, no man could have carried on for several years those successful and brilliant operations on the Hellespont and in the Propontis, by which he so nearly retrieved the fallen fortunes of Athens. Mr. Grote also, following Plutarch, fixes upon Alcibiades the guilt

combated.

of procuring the decree for the massacre of the Melians. But as Thucydides gives not the slightest hint of his participation in that crime, as the usual counsellors of cruelty in the Athenian assembly were not aristocrats like Alcibiades, but low demagogues like Cleon or Hyperbolus (the former of whom we *know* to have proposed the slaughter of the Mytilenæans under similar circumstances a few years before); lastly, as the conduct of Alcibiades towards the vanquished, *e. g.*, at Cyzicus, Chalcedon, and Byzantium, seems to have been uniformly marked by clemency, we may hazard the supposition that this is one of the many scandals (like the story of the drowning of Eupolis) which floated down the stream of tradition, but have really no solid foundation to rest upon.

Were the Athenians right in suspending Alcibiades after Notium?

Upon one other point we shall venture to express our total dissent from Mr. Grote. He justifies the conduct of the democracy in depriving Alcibiades of the command after the defeat of Notium. In this he runs counter to the judgment of Thucydides (vii. 15), and also, if we have rightly interpreted the passage in the Ranæ (see above, p. 285), to that of Aristophanes. Mr. Grote's reasoning amounts to this:—Alcibiades had disappointed the reasonable hopes of the Athenians; with the powerful force under his command, he had effected nothing during a long period; by his culpable absence from his post, and delegation of his own duty to an incompetent subordinate, he had been the occasion of the disaster of Notium; the Cumæans at the same time brought a charge against him of having wantonly attacked their city and territory;—*ergo*, the people were justified in depriving him of his command. To this it may be replied, that Alcibiades left Athens "in the third month" (Xen. *Hell.* I. 4) after his arrival there in May, that is, about the end of July or the beginning of August, and that he was superseded before the end of the year. Not so very long a period this, during which to achieve no decisive success: but in fact Alcibiades *had* gained a victory at Andros. The defeat at Notium was certainly unfortunate, but it did not alter the position of affairs, for Alcibiades challenged Lysander to an engagement immediately after it, but in vain. If commanders-in-chief are to be recalled for such mishaps, as well might the British nation have indignantly deprived Sir Colin Campbell of the command in India because General Wyndham was defeated at Cawnpore! The complaint of the Cumæans, mentioned only by Diodorus, constituted,

if true, a very serious charge. But the Athenians well knew the extreme difficulty,—the city itself being now too poor to furnish the funds,—which their commanders experienced in raising money to pay the troops while on service, and were not likely to have sympathized very profoundly with the sufferings of the Cumæans, had not other motives of ill-will been worked upon. The simple fact seems to be that they acted on this occasion with that foolish precipitancy which a democracy existing without checks is so apt to indulge in. They dismissed the great commander who had fought so many campaigns without once sustaining a defeat, and whose name alone was worth a hundred ships; and in consequence, as Thucydides says, they "not long after ruined the city"; for the subsequent victory of Arginusæ was merely a temporary check in that career of victory which began for the Lacedæmonians on the day when Alcibiades disappeared from the Ægean.

Sketch of the life of Alcibiades: Such is a brief and imperfect retrospect of the various judgments passed upon Alcibiades in ancient and modern times. We proceed to endeavour to present our own portraiture of this remarkable man, adopting, to avoid formality, the biographical style, but sketching the historical facts in the merest outline, and only so far as they are illustrative of character.

his birth and education. Alcibiades, son of Clinias and Dinomache, was born at Athens about the year 452. His father, dying while he was yet young, appointed Pericles his guardian. Pericles, according to Plato (I. *Alcib.* 37), gave him for a tutor Zopyrus the Thracian, one of the most aged and inefficient of his domestics. But we may be sure that, young as he was at the time of the death of Pericles, he had mixed in the brilliant society which gathered round Aspasia, and derived from it in the fullest measure whatever of good or of evil it had to impart. An anecdote told by Plutarch illustrates the force of character which he displayed even in boyhood. Playing at dice in the street one day with some other boys, it fell to his turn to throw. Just then a loaded cart drew near; the other boys made way for it; but Alcibiades, intent on his game, threw himself down flat in the road, and told the carter to drive over him if he dared.

Intercourse with Pericles. In his personal intercourse with Pericles, the difference of age, joined to the lofty reserve of the great statesman, must have prevented much sympathy. Anecdotes indeed on the subject are not wanting. Not to mention the celebrated story of his advice to Pericles about rendering

his accounts, related, but with striking differences, by Diodorus and Plutarch, there is a curious anecdote in Xenophon's *Memorabilia*, relating how Alcibiades posed his guardian by a series of cleverly put questions, *more Socratico*, on the subject of law. Even if not strictly true, the anecdote is an evidence of the opinion entertained by his contemporaries of his intellectual powers. Of Critias, whom Xenophon associates with Alcibiades in this place as another distinguished pupil of Socrates and an able politician, the anecdotes related point to no such conclusion.

Intercourse with Socrates. Socrates, perhaps, first met Alcibiades in the *salons* of Aspasia. The extraordinary personal beauty of the young man—a quality to which all Greeks were so susceptible—may have first attracted him; but it was the "soul of Alcibiades" (I. *Alcib.*) which permanently fixed the philosopher's regards. It is not difficult to understand why. A generous nature desires to find in the object of its affection that which supplements itself; and Alcibiades possessed largely just those persuasive and commanding qualities which nature had denied to Socrates himself. Alcibiades, with his grace of bearing and godlike beauty, was formed for a great orator; Socrates, with his brusque manners and grotesque countenance, could only be a talker. The genius of Alcibiades, though not averse to speculation, tended to action; the genius of Socrates, though highly valuing action, tended to speculation. Of Alcibiades, about the beginning of the Peloponnesian war, it might doubtless be said more truly than of any other Athenian living: "There is a man in whose hands are the keys of the future; whose ambition is boundless, whose activity is untiring, whose talents are equal to his ambition;—rule him, and you will rule Athens, and through Athens influence the destinies of the civilized world. Imbue Alcibiades with philosophy, so that his whole nature shall be possessed by it, and you will see theory become practice; and the ethics of Socrates, after vitalizing the policy of the dominant Hellenic race, will be ultimately reflected from the laws, the manners, and the civilization of a pacified Greece and a subjugated Asia". If Socrates took some such view as this of the character of Alcibiades, we can better understand the intensity of his attachment and the earnestness with which he endeavoured to gain his confidence. In the first Alcibiades (ch. 4), after showing that he has fathomed

the boundless ambition of the youth, which would not suffer him to be contented, even if some god were to promise him absolute dominion in Europe, but would then impel him to cross over to Asia, and never let him rest until he had "filled with his name and his power all mankind", the philosopher proceeds: "Now it is impossible for thee to bring these aspirations to a rational result without my assistance; so great influence I believe myself to have over thy affairs and over thee". At the close of the dialogue, Alcibiades, who is represented as fairly subdued by the logic of Socrates, promises that he will henceforth enter upon the study of virtue and justice. Socrates, in reply, uses these remarkable words: "Gladly would I see thee continue so minded; yet I am filled with apprehension, not from any want of confidence in thy natural character, but when I contemplate the strength of the city, lest it should master both me and thee". Profound and suggestive prognostication! Where Socrates felt himself weak was in the ability to supply a *motive* sufficient to sustain his pupil in the practice of that virtue whose abstract excellence he clearly saw, against the torrent of opposing example by which he would be surrounded in the world. "Athens will be too strong for you; its corrupt moral atmosphere will infect you; you will not purify it". This inability to supply the adequate *motive* is, of course, the weak spot in all philosophy; here it must be supplemented by religion or it will fail. Nay, even against religion itself, is not "the strength of the city" at all times a counter-agent of marvellous efficacy? How many gifted minds, which no intellectual bar, at least no insuperable one, divides from the Catholic faith, are kept from embracing it by the dazzling spectacle of the greatness and success of England, and by the pressure which the example of her vigorous and high-spirited people exerts in the opposite direction!

The teaching of Socrates inadequate to purify the moral nature of Alcibiades, and why.

The pleadings of Socrates for the supreme authority of justice and virtue in human affairs, have long since been recognized and accepted by the world, and will be treasured as long as literature exists. But upon Alcibiades, as the mind of the philosopher misgave him, they produced no permanent effect. Virtue, as an abstract idea, may possibly engross the feelings and influence the conduct of the lonely thinker, whose life is led apart from the thronging market-place, and whose reflective tendency saves him from many temptations to which the men of action are

exposed. But with these last it is usually otherwise. Virtue must come to them in the concrete, must be clothed in a personality, must be in short, what religion paints her—the effluence of a God incarnate,—not what philosophy paints her—the theoretic perfection and harmony of the human faculties, if she is to stand much chance of curbing their proud wills and chastening their fervid passions. Accordingly the "strength of the city" was too much for the lessons of Socrates; and the low moral tone of the Athenian democracy supplanted, because it was present and vital and strong, the beautiful but cold ideal which the philosopher had conjured up before his pupil.

Alcibiades enters public life;

It was not till shortly after the peace of Nicias (B.C. 420) that Alcibiades took a leading part in public affairs. He then appears (Thuc., v. 45) as resorting to unworthy trickery in order to discredit the Spartan envoys, and bring about a rupture of the treaty. Yet his motives do not appear to be wholly selfish. According to Thucydides, he really believed that the alliance with Argos was preferable for Athens in point of policy to the alliance with Sparta. His conduct during the next two years throws light on his motives. Having effected an alliance between Athens and the Argive confederacy, consisting of Argos, Elis, and Mantinea, he marched at the head of a small Athenian force into the Peloponnesus, and with extraordinary zeal and ability endeavoured to organize at her own doors a powerful opposition to the ascendancy of Sparta. His success was at first great; and perhaps he was already flattering himself that the first act of his life's drama was to close with the humiliation of Sparta; but the rout of Mantinea, caused by the rashness and indiscretion of the allied generals, baffled in an instant all his plans. On that occasion he seems to have been present as envoy merely (v. 61); had he held the command, the result would probably have been different.

promotes the Sicilian expedition;

For three years we hear little of him. In this interval occurred the slaughter of the Melians, of his supposed share in which we have already spoken. In 415 took place the expedition to Syracuse. There seems no reason to doubt that the chief projector of the enterprise was Alcibiades. The reduction of Sicily was but a portion of it: that done, the numerous cities of the Italian Greeks (Thuc., vi. 90) were to have been induced by force or persuasion to acknowledge the hegemony of Athens; an

attempt on the Carthaginian possessions, and on Carthage itself, was to have followed;—and if the expedition had been but partially successful so far, the great accession of wealth and military resources which would have accrued to Athens would have been all turned against the Peloponnesus, in the hope of crushing finally and for ever the power of Sparta, and making Athens indisputably supreme in Greece. Plato, as we have seen, goes a step farther, and ascribes to him, as if in anticipation of the conquests of Alexander, ultimate designs even upon Asia and the dominions of the great king. By what strange fatality the expedition was at the very outset deprived of the master-mind, the coöperation of which alone could give it a likelihood of success, is matter of familiar history. One or two episodical reflections, to which the circumstances seem naturally to lead, will find a place presently.

becomes an exile; Alcibiades became an exile, and, powerful alike for evil and for good, dealt to his country those crushing blows from the weight of which she never afterwards recovered. Thucydides makes him justify his conduct by referring it to a singular species of patriotism. "That man", he makes him say (vi. 92), "is truly patriotic, who, when unjustly exiled from his country, endeavours to recover it by every means in his power, owing to the greatness of his love and longing for it, rather than he who refrains from assailing it". The meaning is, that while the democracy ruled, he, Alcibiades, could not return; it was his object, therefore, since he ardently loved his country and could not be happy away from it, to establish aristocracy or oligarchy there; but this could only be done by the use of main force, and by reducing Athens to extremities. His fatal eloquence induced the Spartans to send Gylippus to Syracuse, to seize and fortify Decelea, and to encourage Ionia and the islands to revolt. He himself managed the revolt of many of the Ionian cities. All this mischief he effected in the space of three years. In 412 the tide turned. Alienated by various circumstances from the Spartans, he re-attached himself to the

is recalled; sinking cause of Athens. For the ensuing five years he laboured with a true self-sacrificing patriotism to undo the evil he had wrought, and to restore to Athens her old

his services; supremacy. The victories of Abydos, Cyzicus, and Andros, the capture of Chrysopolis, Chalcedon, Byzantium, etc., testify to the strenuousness of his exertions and the greatness of his capacity. He was never once beaten by

land or sea. But all was unavailing. Discarded by his foolish countrymen, he retired to live among the wild Thracians, who idolized him; and after having vainly warned the new generals of the disaster which their negligence was certain to bring upon them, he witnessed the ignominious rout of Ægospotami. Soon afterwards his eccentric, self-neutralizing life was brought to a violent close. At the instigation, according to Plutarch, of Critias, his old fellow pupil, and the rest of the Thirty, who could not believe their power to be secure while Alcibiades lived, he was assassinated by order of Pharnabazus, in Phrygia, while on his way to the Persian court. His death occurred in 404, in the forty-eighth or forty-ninth year of his age.

is again superseded.

His violent death.

With an observation or two on some topics connected with the life of Alcibiades we shall conclude this article. The first point which we shall consider is the relation in which he stood to the popular Athenian religion. That he regarded it, viewed externally, as a mass of delusion and absurdity,—embellished, indeed, by art, but valueless in the view of philosophy,—we may hold as a certain fact. A slight intercourse with Socrates would have taught him thus much; and farther than this external view he probably did not go. The religious speculations of Socrates, as distinct from his philosophy, would be too subjective in their character to interest him deeply. The concatenation of causes and effects, the nature and the varieties of human motives,—all that is now called *positive* knowledge,—would present to his mind a character of certainty and reliability, which no philosopher's devout dream, much less any popular legend or ancient mystery, could pretend to. But he found himself living in a society interpenetrated by religious ideas, such as they were, and in whose daily life religious practices were constantly recurring. What wonder if a temper so audacious, an intellect so emancipated from moral or customary restraints, revelled in heaping scorn and ignominy even on the most sacred and interior portions of the religion of the vulgar;—if, in the house of the wealthy Polytion, Alcibiades, with a number of equally reckless companions, burlesqued the mysteries of Demeter and Persephone, and acted himself the part of high-priest in the travestie which they performed on the solemn drama of initiation!

Special topics: 1. the relation in which he stood to the popular religion,

which he despised,

It was an enormous mistake, to say the least, and its

but which crushed him at last.

consequences blasted the life of Alcibiades, and ultimately involved a wider ruin than his own. But for this, he might have defied his numerous enemies to shake that ascendancy which his towering genius had obtained; but this intolerable deed just supplied them with that basis of attack which they desired. He could out-argue and out-manœuvre the cleverest of his clever countrymen; crush the stubborn Spartan valour by a yet more immovable resolution; and circumvent the wily Persian with an astuteness greater than his own;—but he ridiculed a puerile superstition, and he fell. In the natural order, such genius, such fascination as his were irresistible; but there is a supernatural order also, which equally with the natural pervades the world, the laws of which he ignorantly despised, until they crushed him. What makes the case more singular is the fact that the Athenians were anything but a strait-laced or Pharisaical people. Aristophanes could with impunity turn the Olympic gods into ridicule before the assembled people, and even introduce them as low and comic personages on the stage. But they felt that Aristophanes was laughing *with* them, while Alcibiades was laughing *at* them; and this made all the difference. Heathen worshippers have often been known to abuse and even belabour their idols, when they imagined them to have turned an uncivilly deaf ear to their petitions, while yet their belief in the reality and power of their deities remained unshaken. So the Athenians could enjoy the scenic representation of Dionysus as a sort of pot-bellied, cowardly Falstaff; yet the next Dionysia would not be the less reverently and solemnly celebrated. But an act which seemed to imply a deliberate rejection of their religion, they could not forgive. Nor is their tenacity on this head uninstructive. For their religion,—corrupted and corrupting though it was,—and especially the mystic portions of it, which Müller supposes to have been, in part at least, relics of the ancient simpler worship of the Pelasgians, contained a tradition and a trace, however absurd and mutilated, of the primeval revelation of the Divine law to man: on it depended, in great measure, the organization and interdependence of parts of their social fabric;—with it were bound up the sanctity of marriage and the sanction of covenants;—and it was a true and sound instinct which urged them to preserve religion from attack, although in any particular instance their mode of vindication may be open to the

gravest censure. Religion then marred the mighty projects of Alcibiades, as it has marred so many other promising schemes;—it is an element in human affairs which may be pure or may be corrupt; but in either case he who contemns it reckons without his host. The English civilians, for instance, who thought to ignore it altogether, and govern India on the principles of the "Philosophie Positive", have terribly expiated their error;—again, the Americans, who seemed to have so thoroughly succeeded in hunting religion out of the highways into the byways of life, and relegating it to the domain of the private, the voluntary, and the speculative, now behold a religious war of the most odious and humiliating kind on the point of breaking out within their territory; and Mormonism teaches the American Universalist, as Polytheism taught the sceptical Alcibiades, that there is an error somewhere in those generalizations, which treat of man as amenable solely to physical laws, and that as the common air is needed for the bodily existence of the individual, so religious faith is necessary to the moral existence of a nation.

2. His representative or typical character,

To one other topic we will, in conclusion, briefly advert. This is, the typical character of Alcibiades, as a representative of "the genius and the moral frame" of the Athenian people. In the history of every great people we meet with remarkable individuals, who exhibit in a combined and concentrated form those qualities which are recognized as peculiarly characteristic of their countrymen in the mass;—thus Leonidas was the ideal Spartan; the Duke of Wellington was often said (though of Irish birth) to represent remarkably well the national character of England; and Napoleon, who was partly French, partly Italian, is said by Mr. Carlyle[1] to have been the typical Italian in his earlier, the typical Frenchman in his later career. But Alcibiades represents Athens with an exactness which not one of the above instances can parallel.

Illustrated by reference to the sketch of the Athenian character in the Funeral Oration.

Take, by way of illustration, the celebrated sketch of the Athenian character in the funeral oration of Pericles. Observe what prominence is given in this sketch to the intellectual and æsthetic superiority of the Athenians over the neighbouring nations, and how, the object of the orator being of course to paint everything in the fairest light, this superiority, leading as it did to energetic and well-directed action, is described

[1] Lectures on Hero-worship.

as compensating, and even more than compensating, for any moral deficiencies that might be attributed to them. And indeed if genius without virtue could preserve an empire, the Athenian hegemony might have endured to this day; for no people, as a people, ever equalled them in intellectual endowments. But in a God-made world this cannot be, and hence the moral delinquencies of the Athenians became the cause of their downfall. Now Alcibiades presents this peculiar type of character most remarkably. Let us take the several features one by one as Pericles enumerates them. First (ch. 37) we are told that the Athenians were not strait-laced nor over censorious, *e.g.*, like the Spartans. This freedom of manners we see developed in Alcibiades to the pitch of licence. The "observance of the laws" next attributed to the people, does not certainly suit the individual, except in that large sense in which (compare Thuc., vii. 89) he threw himself heartily and sincerely into the political forms which he found existing, because his keen discernment taught him that Athens could not be great under any others. He was no *doctrinaire* or political fanatic, like our Mazzinians of the present day; and although he thought aristocracy a sounder principle of government in theory than democracy, he did not consider that a sufficient reason for revolutionizing a state of things which had prescription in its favour. Next (ch. 38) we are told that the Athenians "relieved the toil of their spirits by the refined enjoyments of art, by games and festivals, and by the elegance and taste which embellished their private life". So Alcibiades was a great patron of art, and himself a skilled musician,—a great winner on the turf (as we should say), for three of his chariots carried away prizes at Olympia in the same year,—and a rival of the very Persians, as we have seen, in the luxury and splendour of his private establishments. Again we are told (ch. 39) that "genius and natural high spirit supplied the place for the Athenians, in times of danger and trial, of that ascetical training practised by Sparta"; that they were "brave not by rule but by temper and disposition". These words precisely explain the extraordinary success of Alcibiades in all his military operations. His genius was more than a match for the Spartan tactics and training. Again (ch. 41) the quality of "graceful and happy versatility" is mentioned as an Athenian characteristic. How remarkably it appertained to our hero we have already noticed. "Pushing enter-

prise and expansive daring" are next mentioned; qualities on which the whole career of Alcibiades is one continued comment. Lastly, the circumstance of being the object of very general hatred, mentioned by Pericles in his speech during the plague (II. 64), as the inevitable concomitant condition of the greatness, ambition, and ceaseless activity of Athens, was conspicuously the case, and for the same reasons, with Alcibiades. "His enemies" are continually mentioned in connection with his name by Thucydides, Xenophon, and Plutarch; the two latter of whom state, that even after the vote for his recall had passed the assembly, he could scarcely visit Athens with safety on account of the number and rancour of his private enemies.

THOMAS ARNOLD.

ART. III.—*On a Uniform System of Weights, Measures, and Coins for all Nations.*

CALCULATIONS connected with money, weights, and measures make up a great part of the active business of life; and by far the most extensive application of the science of numbers is that made in our daily transactions of buying and selling. Few who are engaged in such calculations will be prepared to state that, considered as arithmetical exercises, they are accompanied with any peculiar intellectual pleasure. The astronomer, who labours over an apparently inextricable mass of numbers, usually feels some interest in a task which even in its progress unfolds relations of symmetry in the arrangements of the material universe; yet he would gladly welcome new processes of computation, which, without impairing the accuracy of his results, would diminish the labour necessary for their evolution. It is, therefore, extremely natural that persons engaged in the ordinary calculations of every-day business should, in like manner, be willing to adopt methods for lessening the time and labour devoted to their computations. In order to arrive at sound conclusions on this question, it is first indispensable to consider the means employed in all kinds of calculations. **Simplicity important in business calculations.**

Mankind have been so long and so universally accustomed to count by tens, that the decimal system of nume- **Mode of counting**

universally adopted by mankind

ration has become associated in our minds with the groundwork of all numerical computations. But this might have been otherwise, and if man had been created with four or six fingers on each hand, instead of five, we should most probably now employ either eight or twelve as the *modulus* of our numerical system. Much might. be said as to the advantages attending the employment of either of these numbers as a numerical modulus, but such remarks would be wholly speculative at the present day, and would probably never possess the slightest practical utility.

should be employed with reference to all countable things.

The calculations of trade have reference either to objects capable of being directly and separately counted, such as pieces of money, or of being counted by comparison with other objects, such as most of the solids and all the liquids that are commercial commodities. Such substances must generally be weighed or measured before they can become subjects for computation. In order to effect these processes in such a way as to attach definite notions to our results, we refer all weights and measures to certain fixed standards. Had we only one coin, one weight, and one measure, as we have only one UNIT in arithmetic, much practical inconvenience would result; and accordingly civilized nations have been long accustomed to employ a great variety of coins, weights, and measures. Every single member of each of these classes has usually some fixed numerical relation with the other individuals of its class; but, as the fundamental standards employed by different nations have been generally different, so have been the relations among their groups of coins, weights, and measures. Yet as these relations necessarily form what constitutes the subject matter of ordinary computations, it follows that they should harmonize as closely as possible with the numerical system employed in such computations. If, therefore, we count numbers, considered as abstract representations of countable things, by tens, we should also count the real things themselves in the same way, whether they happen to be coins, weights, or measures. In other words, having adopted a decimal system of arithmetic as a pure science, a decimal system of counting objects to which it is applied will be the easiest and most natural. Had we a duodecimal or any other system of arithmetic, a corresponding system of counting coins, weights, and measures would be the simplest; but with our actual system of computation, calculations referring to objects whose rela-

tions are discordant with that system, must be attended with increased trouble and complication. These general arguments are true not merely to-day, but were equally true thousands of years ago, when man first commenced numbering; they are true not merely for us, but for every nation on the surface of the Earth. The rigorous truth of these conclusions has, moreover, been verified thousands of times in practice, and is now apparently universally admitted; yet different nations have for centuries employed systems of coins, weights, and measures, not only unconnected one with the other, but framed without any immediate reference to the system of numbering which has been almost instinctively adopted by every family of the human race.

Resistance to analogous improvements illustrated, by the

Although an important advance has been made in recent times towards the establishment of an improved system, the great nation which has had the honour of taking the first step in this rational course, has as yet been followed by but few others,[1] and by none belonging to the limited number which can bear comparison with her, in population, territorial extent, and material resources. Improvements which require the most simple change in a man's mental habits, even when these improvements spare trouble to the lazy mind itself, are often slowly received by an individual: such improvements are surrounded with difficulties incomparably more serious when a great number of minds must agree before they can be adopted.

Arabic numerals,

Our simple and elegant arithmetical notation, usually called the Arabic system of numerals, made very gradual progress into Europe, through Arabia, from India, where it was originally invented. Its advantages over the Greek and Roman systems of notation are so immense, that its absence was undoubtedly the principal cause of the remarkably imperfect condition of the calculating portions of astronomy and mathematics among the ancients, compared to pure geometry and its applications. To the influence of Pope Sylvester the Second is mainly due the adoption of the Arabic numerals during the middle ages in the South of Europe. But centuries elapsed before they

[1] The system is now either in actual operation, or its introduction has been sanctioned by legislative enactments in the following states besides France, namely, Belgium, Greece, Spain, Sardinia, Holland, Lombardy, Switzerland, Modena, Mexico, Chili, Columbia, and Costa Rica. The well known union of the German States (Zollverein) for weights and measures has in part adopted the French metrical system.

entirely displaced the complex and cumbrous Roman numerical symbols among the northern nations. The Arabic numerals were unknown in Russia until the time of Peter the Great; they were employed in England about two centuries before, but there, the barbarous Roman system still lingered among the accounts of the exchequer down to a very recent time. And this improvement was even for a while successfully resisted by one of those statesmen[2] whose rank is usually supposed to supply all the qualities required for managing public affairs. The progress of the higher departments of the exact sciences was greatly retarded in England during the last century by the adherence of mathematicians to a system of notation much inferior to that employed on the continent. This arose in a great measure from natural though misdirected feelings of veneration for the memory of Newton; just as if the Genoese were to retain precisely the same methods in navigation and seamanship, as those which had been employed by Columbus. More than a century elapsed, before Newton's countrymen were able to understand that the splendid heritage which he had bestowed on mankind, was best cultivated by more manageable weapons than had been employed by the illustrious discoverer himself. In like manner, although incontestably better than that previously employed, our present mode of computing time, according to the Gregorian calendar, came very gradually into operation, except in Catholic countries, and at this day it is not yet universally adopted. In England, when the proposed reform of the calendar was first brought under the notice of the Duke of Newcastle by Lord Chesterfield, it appears that the minister was much alarmed at the project. He entreated the earl not to stir matters that had remained so long quiescent, and expressed his personal disinclination to *new-fangled things*.[3] With such powerful arguments in favour of retaining the old system, it seems wonderful that it has not held its ground up to the present day.

by modern mathematics,

and by the Gregorian Calendar.

Cosmopolitan nature of a decimal system of coins,

As a decimal system of coins, weights, and measures appears to have no peculiarity of a merely provincial or national character, which would adapt it solely for employment within the confines of any separate nation, it is reasonable to suppose that its general adoption by all na-

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[2] Lord Grenville.

[3] See Maty's Memoirs of Lord Chesterfield, section vi.

tions would be universally attended with similarly beneficial results. Not only would the internal transactions of each country be simplified, but its external commercial intercourse would also be greatly facilitated by the similarity of its metrical and monetary arrangements with those of surrounding countries. This result would be yet more decisive were common standards adopted among the several countries. Here the peculiarities and habits of different races doubtlessly present some reasons for existing differences, and will probably interpose some obstacles to the final adoption of an universal system. Although the fundamental ideas of measure, weight, and value are now nearly alike among civilized nations, they are not so completely identical as the elementary notions of number. The primitive units of lineal measure appear generally to be derived from the dimensions of parts of the human body. Thus the foot has its equivalent designated by a corresponding word among all European languages, but its value is not the same in any two countries. Our first notions of weight are derived from the muscular effort required to sustain a mass of matter, and the commonest instrument for roughly estimating the relative weights of bodies is the hand. Arbitrary ideas of weight thus arise among men, according to their varieties of strength and physical constitution. The designations of certain units of weight also indicate their arbitrary character: thus the "stone" accounts by its very name for the actual varieties in the weight it represents. The fundamental notions of value among mankind, although still somewhat arbitrary, have been long approximating to a condition of uniformity, owing to the wide-spread circulation and universal adoption of the precious metals as representatives of wealth. A certain definite quantity of one of these metals, or of an alloy in fixed proportions, would thus assuredly be a sufficiently intelligible standard of value among all civilized nations.

weights, and measures.

The formation of a uniform system of weights, measures, and coins for all mankind would thus require a twofold operation—the adoption of the same standards, and, in the subdivisions and multiples of these for smaller or greater values, the employment of that decimal system of numeration which in their arithmetical system mankind have *already* universally adopted. Nor is it solely to the metrical arrangements of separate and independent nations that this double operation would apply.

Twofold operation for producing uniformity of weights and measures

necessity for its application in Great Britain and Ireland.

In some countries we find a multitude of provincial weights and measures, as different from each other as those belonging to entirely different races. The weights and measures of Great Britain and Ireland are thus far from being uniform in any sense. They are not only arranged without reference to the decimal enumeration, but are variable in value and in name, in different counties and provinces. Selecting a few from numerous examples of metrical curiosities, it appears that while the length of a rood at Preston is from 16½ to 24 feet, in the Vale of Leven it is 36 yards or 108 feet. The Irish acre contains 7,840 square yards, the Scotch acre 6,084. In some parts of England an acre means 4,840 square yards, while in others it means 10,240. The square rood sometimes amounts to 1,210 square yards, and sometimes only to 30¼. A bushel of wheat at one place contains 60lbs., at another place 488lbs: at Dundalk a bushel is equivalent to 20 stones; at Saltash, to 8 gallons. At Scarborough a weight of corn means 40 stones; at Whitehaven, 14 stones. The weight of a pound of butter is not always estimated in the same way even in the same locality; thus, at Stoke-upon-Trent a pound of this article might vary from 16 to 24 ounces. The hundred weight is, of course, *never* 100 lbs., but usually 112 lbs., and frequently 120 lbs. A complete list of all the names attached to the provincial weights and measures of Great Britain and Ireland would occupy more than a page, and would unquestionably present some points of interest to the philologist and antiquary. The confusion and trouble arising from these diversities in estimating the weights and quantities of articles of produce, has long excited attention and loudly demanded a remedy. In Ireland, as well as in England, complaints have been frequently uttered, commissions of inquiry instituted, blue books printed, and yet the only possible complete solution of the difficulty is constantly avoided.[4] The apathy or open opposition presented by successive British administrations during the last half century to the formal introduction of a uniform

[4] The Agricultural Society of Ulster has honourably distinguished itself by passing a resolution, about the commencement of the present year, strongly recommending a decimal system of weights and measures; and a memorial was drawn up, praying for their legal introduction in connection with fairs and markets. The contemplated government measure was justly characterized as entirely inadequate to mee the requirements of the country.

decimal system of weights, measures, and coins into the commercial system of England, will probably hereafter be pointed out in history as a remarkable instance of the superior influence of prejudices and mental indolence over the strongest claims of general utility and common sense.

The French weights and measures formerly in a very confused state;

The country to which the human race owes the first step towards the establishment of a metrical system in perfect harmony with our universal numerical system, is France. From what has been said regarding the provincial systems of Great Britain and Ireland, it will not appear surprising that France should at one time present a similar mass of confused and embarrassing weights and measures. The gradual growth of that country by the successive aggregation of its provinces, by treaty or conquest, from the most fertile and populous districts of central Europe, was highly favourable to the preservation of local peculiarities. Each newly-added province usually retained many of its laws, customs, and fiscal arrangements. It was often considered a privilege to retain what was bad, as well as what was good, and thus each provincial system of weights and measures was scrupulously preserved. Thus it happened that, previously to the Revolution, commercial transactions between remote parts of the kingdom were nearly as embarrassing as with foreign countries.

their reform totally unconnected with revolutionary excesses;

At that early period of the Revolution, when it seemed only destined to apply wholesome remedies to the frightful abuses which had so long preyed upon the lives and happiness of the people, the confusion of weights and measures attracted the attention of the Constituent Assembly. The operations proposed for remedying these evils, and the manner in which they were carried into effect, were totally unconnected either with the absurdities or atrocities of the Revolution. It is important to dwell on this fact, for while few circumstances have more seriously retarded in other countries the reception of the French metrical system, nothing has interposed such obstacles to a fair appreciation of its merits, than the prejudices arising from its supposed connection with anarchy and violence. Such prejudices will presently be shown to be entirely groundless, for it will appear that the course of operations required for the establishment of the metrical system on a sound philosophical basis had nothing to do with the period of anarchy and terror, ex-

cept that of being seriously obstructed; and for some time these operations were suspended by the very men whose names are now universally employed to personify political furor in its most odious form. But had the metrical system emanated from the party to which so many deeds of ferocious atrocity are ascribed, this would scarcely suffice as an objection, when the improvement, regarded as a result of science, might prove beneficial to man. Whatever associations may be connected with an invention, if it is good in itself, common sense will not reject it. Had Archimedes discovered the fruitful principle of hydrostatics with which his name is indissolubly associated, not by inquiries undertaken to determine the composition of Hiero's golden crown, but for the satisfaction of a whim of the bloodstained Dionysius, we would not the less recognize the immense value of that principle in physical science, as one of the most important aids to experimental investigation, and we should not cease to apply it in the useful arts, as furnishing the most correct and simple method we possess for detecting specific differences between an endless variety of materials. The chronometer, by the aid of which mariners can now determine the position of their vessels on the ocean so much better than their predecessors at a period not more than a century from the present day, owes its principal improvements to repeated and liberal offers of reward from the English government; when at the same moment a large proportion of the inhabitants of these islands had the benefit of knowing from experience the nature of a legalized and permanent reign of terror; when, for instance, a priest detected in the performance of functions regarded as most sacred by the majority of Christendom, furnished thereby the most conclusive evidence for being handed over to the finisher of the law, and provided the detective with the strongest claims for remuneration. It is true, indeed, that the unparalleled atrocity of this law caused it to be frequently disregarded, but it was not altogether inoperative. In the course of the very year when the improvements in finding longitudes at sea were so liberally and justly rewarded, a member of the noble house of Talbot was arraigned for having said Mass, and only escaped death from the want of sufficient evidence. Yet, were any person even to hint at these revolting circumstances in order to prejudice the world against the employment of chronometrical im-

if it were, this could not affect the the result.

provements in finding the longitude at sea, he would be laughed at as a simpleton, or pitied as suffering from mental disease. Although the French metrical system is not openly criticised on similar grounds, yet such allusions and references to events of the Revolution have been sometimes made by those who object to the extension of that system, as sufficiently indicate the source from which they arise in minds so far resembling those of revolutionary anarchists as to see history exclusively through a mist of political prejudices.

The metrical system had nothing in common with the Republican Calendar.

The new metrical system has been sometimes erroneously connected with what is called the Republican Calendar. The former had been proposed long anterior to the latter, and while the metrical system originated from philosophical views, the calendar was a mere transient aberration of political fanaticism. Its authors could scarcely have intended it to become universal; and if Alexander von Humboldt had previously published his map of isothermal lines, the calendar would probably never have been proposed, at least as a philosophical system. In Ireland we would sometimes pass through the month called Nivose without snow, while an inhabitant of the southern hemisphere might amuse himself with skating during Thermidor, and might watch the fall of the leaf during Germinal.

Proposals in France for its establishment.

The views developed by La Condamine (1748) had long rendered the question of uniformity of measures familiar in the scientific circles of France; but in 1791 the proposal of a new system of weights and measures began to be discussed not only among scientific men, but also among some of the people who suffered from the confused state of affairs in the provinces. In the spring of 1788 the matter occupied the serious consideration of the Constituent Assembly; and a report was adopted on the 8th of May, in which the king was entreated to write to his Britannic majesty, in order that he would obtain the coöperation of the English legislature with the National Assembly for the determination of a natural unit for the comparison of weights and measures, so that, with the sanction of both nations, an equal number of commissioners, chosen from the Academy of Sciences and from the Royal Society, could meet, in order to find at the parallel of latitude half way between the equator and the pole, or any suitable parallel, the length of the second's pendulum. From the length so ascertained the representatives of the two nations

were then to deduce an invariable standard for a new metrical system. In August of the same year the Constituent Assembly fully ratified this report, charging the Academy of Sciences with the determination of a system founded in nature and destined to permanently supersede the varied and jarring systems existing throughout the provinces of France. It was also proposed that the new system should be so framed as to render it acceptable to the tastes and applicable to the wants of the other civilized families of mankind. The Academy resolved therefore that its divisions should be connected according to the decimal scale, and that the units of surface, capacity, and weight should all depend on the unit of length. To determine the absolute magnitude of this unit, and to fix on a suitable standard for its comparison, became a problem of fundamental importance. The commissioners appointed by the Academy to decide on this question were Lagrange, Laplace, Borda, Monge, and Condorcet. After discussing the relative merits of the invariable length which is known to be required for the exactness of a second's pendulum at any given latitude, and of a unit taken from the dimensions of our planet, they decided on preferring the latter, as not involving the heterogeneous element of time, and being also necessarily of a more cosmopolitan character. The ten-millionth part of the arc of meridian comprised between the equator and the pole was therefore selected as the unit of linear measurement. It was assumed that, as long as the Earth continues in habitable conditions for the human race, its dimensions cannot sensibly change, and that, consequently, if the national standards of length should through physical or political causes be lost or injured, their true values could always be recovered by a direct remeasurement of the Earth, or by a fresh determination of the length of the second's pendulum, the relation between which and the standard of length having been previously determined. There cannot be a doubt that this last method would furnish the shortest and easiest mode of recovering the standard, if it happened to be injured or destroyed, for the operation of determining the dimensions of the Earth is one of the most difficult and delicate in theory, as well as tedious and laborious in practice, that comes within the range of the sciences of exact observation. Had the Earth been an exact sphere, it is easily perceived from the elements of geometry, that the measured distance between two places lying on the

Decimal divisions are adopted;

and a fraction of the meridian is selected as the standard of length.

same meridian, compared with the difference of latitude of these places, would enable us to deduce all the dimensions of the globe. The measurement might, in so simple a case, be supposed to be made directly, and the difference of latitude would be found by knowing the difference between the angles formed by the visual ray from any star with the plumb-line at each of the two stations. But the actual problem is far from being so simple as this. The Earth's surface presents deviations from a spherical shape, which, however small compared to its entire magnitude, acquire considerable importance in the exact estimation of its figure and dimensions.

Measurements already executed from which a standard might be deduced.

Long before the proposal had been made in France for adopting a standard derived from one of the dimensions of the Earth, measurements had been executed in different countries. Attempts had been made even at periods of remote antiquity, of which the little we know indicates that science has lost nothing of real value in not possessing the remainder. But if these attempts had been executed with every modern refinement, they would still have been perfectly useless for the objects of the French commissioners, as the lengths of the units of measurement employed in these early determinations have never been satisfactorily ascertained, and will probably remain for ever unknown. More recently, geodesical measurements, intended to ascertain the magnitude and figure of the Earth, had been made not only in Europe, but scientific expeditions had been sent expressly for these objects to parts of the western continent. Some of these operations are closely connected with the most splendid discoveries in the relations of the material universe that have ever been unfolded to the human mind. A result derived from one of the earliest of the European measurements induced Newton to resume certain calculations which he had laid aside as leading to conclusions discordant with observed facts, but the discordance arose only because he had to use among his data an imperfectly determined value of the Earth's radius. On substituting the more correct value, he was able to establish, that the same kind of force which produces the fall of a rain-drop on the Earth's surface, regulates in space the motions of the planets. The more refined measurements which succeeded, while furnishing materials for studying the physical conditions of our planet at remote periods of its existence, have also contributed, perhaps more than any other of the results among the

sciences of observation, to verify the law of universal gravitation, not merely for definite bodies one upon the other, but for every particle of matter on all other particles.

Yet it was resolved to undertake all the preliminary work afresh.

Although it was admitted that an estimate of the standard of length deduced from some previously executed measurements of the Earth, would be more than sufficiently exact for the ordinary purposes of commerce and the arts, it appeared to the French Academy better, both for the sake of science and for the philosophical character with which the new metrical system was to be invested, to make an entirely fresh re-measurement. The inequalities of the Earth's surface, which are most obvious to ordinary observation, such as hills and valleys, prevent the direct measurement of an arc of the meridian. This arc is supposed to traverse a surface to which a plumb-line suspended over any point would be always perpendicular, or along which an observer, carrying a spirit-level, would always find the bubble at the middle of the tube. This surface, although unquestionably not the mean surface of the Earth, yet deviates from it probably in so slight a degree as to render the difference of no consequence, except in those questions of terrestrial physics, in which peculiarities of the internal structure of our planet are attempted to be studied by the aid of such phenomena as are presented to us on its surface. If the positions of certain points which are known to be on the meridian, such as the two extremities of the arc, are ascertained by any process, the length of the interval between them can be calculated. In order to determine the position of such points, a twofold series of operations must be performed; first, a general survey by the aid of methods similar to those employed in the great triangulation of the Ordnance Survey recently completed in Ireland and England; and, secondly, the determination of the positions of the triangles with regard to the meridian. The astronomical determination of the latitudes of the points whose positions have been thus ascertained by terrestrial measurements completes the work. All these operations require a large staff of practised and skilful observers, highly finished instruments of different kinds, and, finally, an ample interval of time before they can be brought to a close. The management of so important an undertaking was intrusted to a commission of the French Academy, of which Delambre and Mechain were the two astronomers more especially en-

gaged in the geodesical operations. The arc selected for measurement is that extending between Dunkirk aud Barcelona, of which the northern and by far the larger portion, extending from Dunkirk to Rodez, was to be superintended by Delambre, while his colleague undertook the management of the operations connected with the remainder. This unequal division of work arose from the presumedly greater difficulty of the Spanish part of the arc, and the circumstance that the French portion had been already twice surveyed by different observers.

Obstacles from the disturbed state of the country.

It was soon found, however, that the principal difficulties were not to be met with across the Pyrenees, but close to the walls of Paris. Mechain had scarcely commenced his journey towards the south, in the summer of 1792, when he was stopped by bands of armed citizens, and kept for a short time under arrest, until regularly liberated by authority. As he advanced, the obstacles to his progress gradually diminished, and he was able to commence his labours without any interference. In autumn he had completed the entire measurement of the angles of the several stations distributed across the Pyrenees and the north-east of Spain. The following winter was to be employed in astronomical determinations at the southern extremity of the arc.

Difficulty in obtaining proper signal marks for the geodesical operations;

Delambre was less successful in France; his first difficulty arose from the want of such prominent and distinct objects as would suffice for marking his stations with precision when observed from distances so great as the intervals between these stations. When the angular distance between two objects, each distant from an observer from twenty to thirty miles, is to be ascertained with the minute accuracy required in a geodesical survey, it is indispensable that these objects should be well defined in outline and clearly visible. Such objects as towers and steeples are well adapted for this purpose; but they are not always so situated as to meet the requirements of the system of triangulation. On this account, artificial signals have to be frequently constructed, usually pyramidal structures of wood or stone. By the aid of powerful lamps, night observations are also capable of being made with very satisfactory results. Under the existing circumstances, night signals were attended with manifest danger, and Delambre and his associates appear never to have used them except on one occasion close to Paris, and then, perhaps fortunately for themselves, in a most imperfect manner. Only

danger of night signals.

a few nights before this attempt, their attention had been excited by a lurid glow towards the south. This arose from burning houses in the Place du Carrousel, for that happened to be the night of the 10th of August, 1792.

The astronomers occupied with the work encounter fresh embarrassments;

Although furnished with passports and other documents emanating from the government, the astronomers found themselves stopped by serious difficulties arising from the disturbed condition of society. The construction of signals was sometimes prevented by the people; the observers were frequently placed under armed surveillance by the district authorities. Much embarrassed by these obstacles, Delambre despatched one of his assistants to Paris to obtain fresh passports, which were rendered the more necessary from changes that had taken place in the supreme power. He prudently abstained from presenting himself, as he foresaw that he would be told to postpone his labours to an epoch of greater tranquillity, and that with such a postponement, an indefinite period might elapse before the undertaking could be again resumed. In the meanwhile he caused his passports to be *viséd* at St. Denis, where he happened to have arrived, and also took the precaution of obtaining a certificate from the district authorities. But these precautions availed little, for in half an hour afterwards the astronomer with his companions were arrested at Epinay. The instruments were regarded with particular suspicion, as perhaps dangerous counter-revolutionary engines; just as, a few centuries before, the same people might have looked upon them as apparatus connected with the mysteries of the black art. Delambre is required to display the instruments on the ground, and to explain their use. As may be readily supposed, not one among such a cultivated audience can understand his explanations. He tries vainly to excite the interest of two surveyors who happen to have got into the crowd, by showing the close affinity between his operations and the labours of their profession. These men would not compromise themselves by saying anything; they dared not oppose themselves to the tone which was now so prevalent among the multitude. After a discussion of three hours, the astronomers were conducted back to St. Denis under armed escort. The open place before the venerable mausoleum of the kings of France was filled with groups of republican volunteers waiting to be armed before marching to defend the frontier. The prisoners had to pass through this motley crowd; their carriages are explored; a heap

they are arrested,

of sealed letters addressed to the authorities of the departments in which the geodesical operations were to be carried on are discovered. The letters are speedily opened and publicly read, when they turn out to be only circulars, in which the Committee of Public Instruction of the National Assembly recommend the bearers to the good offices of the official personages to whom they are addressed. When the curiosity of the crowd had been satisfied about the letters, they next turn to the instruments. These are quickly displayed upon the open part of the square, and Delambre is once more compelled to attempt a lecture on geodesy under circumstances at once terrible and ludicrous. The day was rapidly waning; the last rays of sunset had long since tinged the summit of the cathedral, and objects close to the ground were no longer distinctly visible in the growing dusk of twilight. The first ranks of the numerous audience saw little, and heard without understanding; the more remote heard less, and saw nothing. Impatient murmurs arose; cries began to be heard, suggesting the usual expeditious means employed at the time for cutting short all doubts. The president of the district has the presence of mind to suggest the postponement of further inquiry until the suspicious looking instruments could be examined with the advantage of broad day light; and, affecting a tone of severity, he orders these and all other articles belonging to the astronomers to be placed under seal. Delambre immediately addressed a letter to the President of the National Assembly, entreating some specific measure for the protection of himself and his associates. This was done without delay, so that he was able to emerge, after the lapse of three days, from a place of concealment where he had been obliged to remain since the adventures which had threatened to so abruptly terminate his scientific career.

and in great danger,

which they escape.

For some time after these events, natural obstacles alone opposed themselves to the progress of the geodesical operations. During the spring of 1793 fresh difficulties arose, from the necessity of constantly procuring new passports, and of exhibiting them almost unceasingly at the demand of every local authority. About this period also, the triangulation having been pushed to the northern extremity of the arc, the observers found themselves close to the scene of war, but by changing a few intended stations, they were able to avoid the awkwardness of carrying on

In 1793 fresh political difficulties arise;

their scientific labours in the presence of two hostile armies. The work had now advanced to the south of Paris; and as the triangulation approached the Loire, it was found essential to construct, on the hill of Chattillon, between Pithiviers and Orleans, a signal of considerable dimensions. As this structure was to serve as a kind of geodesical observatory, it had to be so made as to present not only a wide surface to the autumnal and wintry gales that now began to rage, but also a very conspicuous appearance among surrounding objects. The erection thus became a fruitful source of the most absurd rumours, and had to support, along with the fury of the elements, the equally blind attacks of many a village orator.

and the scientific operations are suspended,

Hitherto the obstacles encountered by the little band of scientific observers had been generally such as would naturally arise at any period, and in any country, from the combined influence of popular ignorance with the excitement consequent on a disturbed state of society. But at Chattillon, they became acquainted with a fact which, for a time, put an end to their labours. The Academy of Sciences had been abolished six months previously; but the Commission for Weights and Measures was retained by a special decree. The party now in power was favourable to the metrical system, but had little sympathy with the fundamental operations required for its establishment. A provisional standard of length, deduced from former measurements, was apparently deemed good enough for definite adoption. The commissioners of the metrical system received hints that it would be desirable to rapidly terminate their labours, and that some of them would very soon be dispensed from further occupation. Not long afterwards Delambre received an official communication, enclosing a decree which is here given *verbatim*.

Du troisième jour de Nivose, l'an deuxiéme de la Republique Française, une et indivisible.

by a decree of the Committee of Public Safety.

Le Comité de Salut Public, considérant combien il importe à l'amelioration de l'esprit public que ceux qui sont chargés du gouvernement ne délèguent de fonction ni ne donnent de mission qu' à des hommes dignes de confiance par leur vertus républicaines et leur haine pour les rois; après s' en être concerté avec les membres du Comité d' Instruction Publique, occupés specialement de l' opération des poids et mesures, arrête que Borda, Lavoisier, Laplace, Coulomb, Brisson, et Delambre, cesseront, à compter de ce jour, d' être membres de la Commission des Poids et Mesures, et remettront de suite, avec inventaire, aux membres

restans, les instruments, calculs, notes, mémoires, et généralement tout ce qui est entre leur mains de relatif a l' operation de mesures. Arrête, en outre, que les membres restans a la Commission des Poids et Mesures, feront connaitre au plutôt au Comité de Salut Public quels sont les hommes dont elle a une besoin indispensable pour la continuation de ses travaux, et qu' elle fera part en même temps de ses vues sur les moyens de donner le plutôt possible l' usage des nouvelles mesures a tous les citoyens en profitant de l' impulsion revolutionnaire.

Le ministre de l' intérieur tiendra la main à l' exécution du présent arrêté.

To this document were signed the names of Barère, Robespierre, Billaud-Varrene, Couthon, Collot d' Herbois: thus giving to the decree the character of the strongest testimonial in favour of those against whom it was directed.

Political furor adverse to science.

Delambre himself seems to have thought that the first part of this decree contained only an empty pretext, and that no one would be so absurd as to suppose that he should quit his signals and instruments in order to display in the clubs his republican sentiments and hatred of kings. Political furor is, however, a strong incentive to absurdities as well as to deeds of oppression; and its hostility to science, whenever the latter cannot be degraded into its service, is sometimes manifested in other countries besides France, and by men claiming for themselves much more coolness, moderation, and wisdom, than the terrorists of the Revolution. The discussion carried on in England about the commencement of the American war as to the comparative merits of lightning conductors terminating in round knobs or in points, deserves on this account a prominent place in the history of science. Notwithstanding, as most readers will anticipate, the almost unanimous opinion of British savans in favour of pointed conductors, the contrary views were countenanced in the highest quarters of the state, because it would be unseemly to adopt the invention of a rebel like Franklin. It is said that the resignation of Sir John Pringle, as President of the Royal Society, at this period, arose from his disinclination to imitate the courtiers of Canute, by asserting the supremacy of the royal prerogative over the laws of the creation.[5] Political or personal prejudices, how-

[5] A well known instance of a somewhat analogous character is thus referred to by Humboldt: "It is scarcely necessary to mention that Protestant physicians suffered themselves sometimes to be influenced

ever, do not preclude the possibility that the Committee of Public Safety, careless of the scientific character of the operations then in progress, sincerely desired that they should be hastened to an end, so as to take advantage of the impelling force of the Revolution in propagating the new system of weights and measures, of which they were to form the foundation. If so, this hope was apparently groundless; for it was not until long afterwards, and in times of unusual tranquillity, that the decimal weights and measures commenced definitively to supersede their antiquated predecessors.

Recommencement of operations in 1794.

The suspension of the geodesical operations did not continue much beyond the period at which the power of those who commanded that suspension had passed away with themselves; and in the spring of 1794 arrangements were made for resuming the work nearly on the same footing as before. In the meantime, Mechain had not only to contend with physical obstacles among the Pyrenees, but also with difficulties arising from the war which had broken out with Spain. The signals marking his stations were frequently destroyed, the instruments and even the observers were sometimes imperilled by the fury of those ascending and descending gusts of wind which are so prevalent among the deep gorges of the mountains. The dangers arising from parties of guerillas were fortunately much diminished by the liberality of the Spanish authorities, who, for a considerable time, invariably granted the utmost freedom of action to the French astronomers. At length, it appeared to the general stationed on the frontier, that the information acquired by Mechain and his companions respecting the country traversed during the operations might prove prejudicial to the interests of Spain, and accordingly the astronomer was ordered not to quit the country.

Embarrassments still encountered

In the autumn of 1794, Delambre recommenced his labours in the neighbourhood of the Loire, but his progress was very slow, from the necessity of defraying all expenses with the now greatly depreciated assignats. After an absence of several months from this quarter, in order to execute the tedious and difficult operation of determining with precision the latitude of Dunkirk, he proceeded with the work to the south of Bourges, among

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by religious intolerance and hatred of the Jesuits, in the long controversy that was maintained respecting the good or evil effects of the fever bark"—Views of Nature, p. 423. Bohn's edition.

the central districts of France. Some trouble, and much delay, arose in this part of the country, owing to the manner in which church steeples, that would have afforded excellent signals, had been stunted of their proportions by revolutionary fanaticism. One representative of the people had boasted, in a letter to the National Assembly, that he had levelled those steeples which so proudly reared themselves above the humble dwellings of the "*sans cullottes*". Delambre witnessed everywhere that the humble "*sans cullottes*" regretted very much the loss of their steeples; and, on one occasion, having had to supply a church spire, which his triangulations rendered indispensable, its subsequent removal was prevented by the determined opposition of the entire parish. At another station, having covered with white canvas, to render distinct, one side of a pyramid of planks which occupied the place of a levelled church spire, an alarm arose among the people at the sight of a colour in their eyes so significant of counter-revolution; but a complete remedy was soon provided, by attaching to one side of the white canvas a strip of red cloth, and to the other side a strip of blue. This signal was always respected, while another, only a few leagues to the south, was in constant danger. The very day on which it was erected, a violent storm visited the neighbourhood, and the mountain torrents swept an immense volume of earth and gravel into the streets of the adjacent town, where apprehensions were at the same time entertained for the safety of a bridge across the river Dordogne. The signal was blamed for these disasters, and it had also to bear the imputation of causing the heavy rains which for two months suspended agricultural labours among the mountains. Several attempts were made to cause its removal; but, fortunately, its position was almost inaccessible. All the triangulation of the south having been finished, nothing remained but the measurement of the two bases at Melun and Perpignan. These measurements were terminated without any difficulty, except such as are natural in labours requiring so many precautions, and in which the physical observer is compelled to employ every resource that science can bring to his aid.

about geodesical signals.

Invitations had been long since issued by the French government to neutral and allied countries, in which they were requested to send deputies to Paris, who should assist, along with the commissioners of the Academy of

Commissioners assemble to arrange

the metrical system, Sciences, in the final settlement of a metrical system adapted to the usage of all nations. Such deputies had been accordingly despatched from the Netherlands, Denmark, Spain, Switzerland, and several states of Italy. The entire body of French and foreign commissioners having assembled about the beginning of the year 1798, divided itself into sub-committees; one, for examining the astronomical and geodesical results of the operations whose history has been partly related; one, for determining the relation of the standard so deduced to previously existing standards; and another for fixing the unit of weight.

and to discuss the results of the measurements.

These show certain irregularities in the Earth's figure.

The labours of the first committee resulted in pointing out some hitherto unknown deviations of the Earth's figure and structure from the more symmetrical conditions which it had been previously supposed to possess. The concordance between the numerical results, as well as the skill and experience of the observers, would not allow the commissioners to attribute these anomalies to errors of observation. The dimensions of the Earth finally deduced, differed but slightly from those already assigned by earlier measurements.

Determination of standards of length and capacity.

As the length of the arc of meridian was necessarily estimated in terms of the platinum rods employed in the measurement of the bases, the relations of these rods to existing standards would determine the length of the metrical standard in terms of the ancient system of measures. This comparison was made, as usual in all similar cases, by the aid of an apparatus furnished with sliding microscopes and thermometers, so that the most minute differences between the metallic bars submitted to examination could be readily detected. The comparison in the present case amounted rather to a verification of the rods employed in measuring the bases of triangulation, for these rods had been themselves constructed after the toise or fathom called the toise of Peru, which was deposited with the French Academy. From these different processes it appeared that the ten-millionth part of an arc extending from the pole to the equator was 443.3255 lines of the old measure, and a bar of this length was according adopted as the METRE. When the measured arc was afterwards prolonged to Formentera, this value was altered by less than than its sixty-thousandth part. The length afterwards definitively adopted is 443.296 lines; so that the metre is equivalent to a little more than thirty-nine and one-third English inches. The standards

of surface and capacity, as may be readily conceived, were deduced from multiples or submultiples of the linear standard. Thus a square ten metres long was designated as the standard of surface for land measure; in other words, the value of this unit is one hundred square metres. The standard of capacity for liquids was determined by finding a cylindrical volume equal to a cube whose edges are formed by tenths of the linear standard. This is the *litre*, a measure somewhat smaller in capacity than one of our imperial quarts.

Selection of a standard of weight.

In order to determine a unit of weight in harmony with the rest of the metrical system, obvious considerations present themselves in guiding the choice of a philosophical inquirer. The weight of any substance depends on its density as well as on its bulk. Density is a property of matter which is known to vary not only among different substances, but also even in the same substance when under different conditions. It became, therefore, desirable to choose a body over whose conditions the utmost control could be exercised, and which could also be easily obtained at all times and in every part of the world. Water possessing the required properties, it was selected as the substance adapted to furnish the best unit of weight. Equal volumes of distilled water, at the same temperature and under ordinary atmospherical conditions, are known to have equal weights all over the world. Like all other bodies, water is susceptible of changes of volume by changes of temperature. It expands when heated beyond its ordinary temperature in our climate; and every person who has experienced a warm bath is aware that the water must be agitated in order to perfectly mingle the warmer liquid, which tends to float, in virtue of its comparative lightness, above the colder and heavier fluid that rests at the bottom. When water cools to a sensible degree below the ordinary temperature, it becomes at first heavier, but after losing a certain amount of heat, it again expands and becomes light, so that, when frozen, the solidified water floats above the liquid mass of which it had formed a part. It thus happens that water has a *maximum* of density; that is, at a certain temperature, a given volume is heavier than an equal volume at any higher or lower temperature. Provided that the water is in a state of purity, this *maximum* is invariable. The weight of a litre of distilled water at its *maximum* density was accordingly adopted as the standard of weight, and called a

kilogramme. The preparation of a corresponding mass of metal to be kept for reference, was executed under the superintendence of a skilful physicist, Lefèvre-Gineau, with every precaution required in an operation of such extreme delicacy. This unit of weight had subsequently to be compared with existing units, when it was found to be equivalent to 18827.15 French grains, or a little more than two English pounds avoirdupois.

Nomenclature of the French metrical system.

The units of length, capacity, and weight having been determined, multiples and subdivisions according to the decimal scale were easily framed, and a special nomenclature was devised for the entire system thus invented. This nomenclature had been proposed in different forms, sometimes consisting merely of the names of former measures with a new signification—sometimes with such names slightly modified; that which was at last definitively adopted has no connection with the nomenclature of the older weights and measures. It has nothing French about its character, more than any other group of scientific terms derived from Greek and Latin roots. The words *μέτρον* (measure), *λίτρα* (measure for liquids), and *γράμμα* (small weight), form the foundation of the metrical nomenclature. A thousand times the weight called a gramme, being the most convenient for the unit of weight, was necessarily called a chilogramme, or kilogramme, K being used as the representative of χ for the sake of euphony. The multiples of the units are designated by Greek prefixes, thus: "decametre", for a measure ten metres in length, "hectometre", for one equivalent to one hundred metres. The subdivisions are denoted by Latin prefixes: thus, "decimetre" means a measure equal in length to the tenth part of a metre; while a "millimetre" is the thousandth part of a metre. It is unnecessary to name the rest, and a slight acquaintance with the system shows that most of its terms are nearly superfluous; for the decimal metrical system possesses the great practical advantage of not requiring any technical terms beyond those attached to its units. Thus, instead of writing two hectometres, we might write 200 metres; instead of half a centilitre, $\frac{1}{200}$ litre. This course appears to be the most easily intelligible; and as weights and measures are intended for the use of the great mass of mankind, their terminology should be as free as possible from any appearance of learned formality. Had the new system of weights and measures been intended exclusively for France, it

may perhaps have been prudent to have adopted a nomenclature wholly derived from the vernacular tongue. In the course of a tedious struggle against the active force of prejudices and the formidable inertia of mental indolence, the new metrical system could not have have had any more serious obstacle to its reception among the rural population of France, than its Greco-Latin nomenclature. If that system should be extended to other countries besides those in which it has been already adopted, the terms denoting the units should at most be introduced at first into their languages, the multiples and fractions being expressed by the aid of numbers. Such names are not solely for the purposes of science, where the learner who has any pretensions to acquire knowledge must be prepared to understand compact, though to him strange, terms derived from Greek or Latin roots, which could not be abandoned for corresponding vernacular expressions without the use of a cumbrous and inexact phraseology. A man who never heard of the names of Pericles, Themistocles, or Epaminondas, would scarcely demand their provisional abandonment in a popular exposition of Grecian history, for such names as Smith, Brown, and Thomson, which, although not the most suitable designations of the personages to whom they would be applied, would have the advantage of being more familiar to his ear; and yet the same person would complain of scientific terms, even when fully explained, for no other reason than their unfamiliarity. Absurd as are the objections to scientific language on the part of persons professing to be learners, those useful members of society who are engaged in the active business of life, and who have no pretensions to scientific or literary acquirements, cannot be so fairly expected to quickly master a strange nomenclature applied to some of the objects that constantly occupy their attention and minister to their daily wants.

An obstacle to its reception.

In connection with the formation of a decimal system of weights and measures in France, the coinage was naturally arranged according to a corresponding system. This soon became much better known and more universally employed than the new system of weights and measures. The use of the old weights and measures, slightly modified, had even to be sanctioned by successive governments, until July, 1837, when a law was passed enforcing, from the beginning of 1840, the exclusive usage of the improved system, as determined by the commission of

Gradual progress made by the metrical system.

1798. Its merits are now practically appreciated not only in France, but in every state of Europe and America, where it has been introduced. A few countries, without adopting the French system, have long since employed some system of decimal coinage or measures. Thus in the United States of America a decimal system of coins coëxists with weights and measures similar to those of Britain.

International Association for uniformity in coins, weights, and measures.

The feeling which has been long growing in favour of a decimal system in England, and which parliamentary inquiries from time to time so clearly reveal, has very recently received a considerable accession of strength. The industrial exhibition of 1855, held in Paris, having attracted to that capital an unusual concourse of the thoughtful as well as practical minds of every nation, meetings were held for the discussion of suitable projects for inducing all civilized powers to unite in adopting a system of weights, measures, and coins, adapted to the requirements of all mankind. An international association, centred in Paris, with branches in the principal states of Europe and America, was accordingly organized under the presidency of Baron Rothschild. This body has already effected considerable progress in the objects for which it was established; and, chiefly through the exertions of Mr. James Yates, of London, the English branch has succeeded in exciting a feeling throughout these countries which promises to give the consideration of a new system of weights, measures, and coins, a far wider basis than it had previously possessed.

Reasons for believing that such a system will be universally adopted.

The advantages to the entire human race which a universal metrical and monetary system would confer, are now very generally admitted; but doubts are entertained as to the practicability of so great an achievement. Such doubts arise partly from the known obstacles presented by the habits and mental indolence of the majority of society; but similar improvements have triumphed in every country over the same difficulties, and in some nations a uniform decimal monetary and metrical system has already gained possession of the shop, the counting-house, and the market. A system established in conformity with mental habits that belong to all mankind, which takes its standard of length from the dimensions of the planet of which they are common inhabitants, and its standard of weight from that liquid which is at once the most useful to man and the most universally diffused, cannot assuredly be

accused of exhibiting any peculiarities merely local, or any traces of being subservient to the advancement of the views of a political party. That all these qualities are possessed by the French metrical system, no person can doubt, who examines the history of its origin, and meditates over its philosophical character. Objections, in some measure well founded, have been raised by a few eminent scientific men in England against the adoption of standards found in nature. The length of the seconds' pendulum and the dimensions of the Earth, are the only two invariable quantities which appear to be within our reach; but their determinations do not give strictly the same results in every country. The Earth's figure is not perfectly regular, nor is its structure homogeneous. The meridians in different countries, although curves very similar, are not precisely alike; and the lengths corresponding to the same celestial arc, will differ from one meridian to another. If lines traced on the true surface of the Earth, over hill and valley, were those estimated, the discrepancies would probably be still greater; but those which are measured, although independent of small local irregularities, are affected by the greater deviations of the Earth's figure from an ellipsoid of revolution. The length of an invariable pendulum depends on the intensity of gravity at the place where it is set in vibration. This intensity, as might be expected *a priori*, varies not only in going from the equator to the pole, but also sometimes, though in a less degree and with less regularity, in the direction of the parallels. The differences between the results of dimensions of the Earth, obtained from distant geodesical operations, and of the lengths of the second's pendulum, as determined by different observers at different stations, although far below what are required to be considered in the formation of a standard of length for ordinary operations, yet may become important in connection with scientific determinations where a higher degree of precision is desirable. On this account it has even been proposed to abandon natural standards altogether, and to merely adopt the old system with additional precautions of inclosing the standards in a place of safety, whence they could be obtained for rarely occurring and important national objects, only with great trouble and with the sanction of the highest legislative authority. The establishment of a natural standard does not, however, preclude the fulfilment of such an arrangement—the preserved stan-

Objections to standards found in nature,

shown to be invalid.

dard would always necessarily retain the higher authority; but this should not prevent the existence of some provision against its injury or loss. Even were these contingencies completely obviated, it would manifestly contribute to the cosmopolitan character of a universal standard, if it were either the length of the second pendulum at the equator, or a fraction of the Earth's dimensions, approaching to the truth far more closely than the ordinary purposes of society would ever be likely to require.

Suggestion of a new standard if another should be desirable.

A standard based on no philosophical idea whatever, could only be proposed for the exclusive use of a single nation, and is certainly far from being inappropriate wherever the entire system of division of weights and measures has no pretension to be in harmony with the numerical scale which forms the basis of all computation. The slight deviations of the Earth's figure from that of an ellipsoid of revolution, rendering its meridians dissimilar, might suggest the adoption of another ideal standard, if the subject is really worthy of serious reconsideration. The axis of rotation of the Earth is common to every meridian, and its most correct value is obtained by a comparison of the measurements of several different arcs belonging to different meridians. An easily remembered fraction of this axis might form a standard of length, which would be less liable to vary in its estimated value than a fraction derived directly from an arc of a meridian, the influence of the physical peculiarities of the countries through which the measured arcs happen to pass would be nearly eliminated, and the final result would be of a kind to which every country would have the same relation. We are, however, far from proposing the adoption of a new standard, and we make this suggestion only as a mode for overcoming any difficulties that may impede the reception of the metrical system among those great nations into whose shops and markets it has not as yet found its way.

General use of the decimal system for the purposes of science.

It is natural to suppose that the philosophical excellence and practical advantages of the new metrical system would be most readily acknowledged among scientific circles. It has been accordingly for many years introduced into scientific cabinets and laboratories over the greater part of Europe, and with or without the coöperation of governments, has made itself familiar to a large number of the better educated classes of every country.

Besides the estimation of length, surface, volume, and weight, in science and the useful arts, it is often necessary

to estimate relative quantities of heat. For this purpose, a universal standard presents itself, in the property by which water under the same pressure boils and freezes at fixed temperatures. The interval between these temperatures has accordingly been adopted as the standard for measuring heat. Its division into 100 degrees, long since proposed by the Swedish philosopher Celsius, has gradually superseded the division into eighty degrees introduced by Reaumur in France. The centigrade or hundred-degree thermometer is completely in harmony with the decimal metrical system, and the one is likely to be fairly appreciated wherever the advantages of the other have been felt. Although the somewhat arbitrary thermometrical scale introduced by Fahrenheit has held its ground up to the present time in Great Britain, the inferiority of that scale to its more philosophical competitor is now beginning to be felt, and the latter has been recently adopted by eminent English physicists in an extensive series of researches on the mechanical and molecular conditions of heat. The increasing attention which the climate of the globe is constantly receiving, and the vast number of observations which are now made, both on land and sea, render it extremely desirable that a uniform system should be pursued in estimating the most important of all climatological elements. On this account alone, if a universal system of weights and measures should be established, the thermometrical scale must claim a share in the improvement—a change which will fortunately be of the simplest nature, as it will only require that a selection be made of one scale out of the three that have been generally received among civilized nations.

Estimation of heat according to a decimal system.

The arrangement of coins according to a decimal scale is easily understood. Thus, the franc being the basis of the French coinage, its multiples are—in gold, the pieces of 100fr., 50fr., 20fr., and 10fr.; in silver, those of 5fr. and 2fr. Its hundredth part is called the centime; and the multiples of that in silver are, 50c. and 20c.; in copper or bronze, 10c., 5c., and 2c. These are numbers belonging to the decimal scale, because those less than ten evenly divide it, and those less than one hundred are also even divisors of that number. The introduction of such a system into accounts immediately removes a mass of superfluous figures. In cases where per-centages of sums of money are estimated, no calculation whatever is necessary; all that is required is done by changing the place of a

Present arrangement of the French coinage.

decimal point. The obvious advantages of decimal coinage and accounts have lately forced themselves on the attention of our legislature. All the evidence collected by a Committee of the House of Commons, in their comparatively recent inquiries, points in one direction, namely, that of proving the superiority of a decimal system of coinage and accounts over every other. In order to realize this preference of a decimal coinage, it is proposed to make a few alterations in the present coinage, by which the whole would become decimalized. Calling the thousandth part of a sovereign a mil, the proposed scale would stand thus:

Decimal coinage of Great Britain recommended by a Committee of the House of Commons.

1,000 mils=1 sovereign.
500 mils=½ sovereign.
250 mils=1 crown.
100 mils=1 florin.
50 mils=1 shilling.
25 mils=6 pence.
20 mils=2 cents.
10 mils=1 cent.
5 mils=½ cent.
2 mils, and
1 mil.

The cent and mil would thus be entirely new coins, the value of the former being nearly 2½ pence, and that of the latter less than a farthing by only its $\frac{1}{24}$th part. It is proposed to make the cent a silver coin, while the three inferior coins are to be copper.

If this improvement should be effected in the manner proposed, it will probably soon lead to a similar reform in weights and measures. It is said that the people would soon be demanding a decimal metrical system in everything; but why wait in a question of this nature for demands from the people? The reform is not of a nature calculated to make a stirring party cry, or to excite the political feelings of the multitude. After Lord Chesterfield had prevailed upon the legislature to pass his bill for the establishment of the Gregorian Calendar in England, and when he heard from the crowds surrounding his carriage, cries of "give us back our three months", he would assuredly smile at the simplicity of any one who would say that we should make no improvement in our mode of counting time or space, except as a result of popular expressions in its favour. If, therefore, the indisputable merits of a decimalized system of weights and measures, as well as of coins, should render its establish-

Similar steps for weights and measures

ment desirable, why should not some attempt be made to mould it in harmony with the systems of other nations? The evils resulting from the existing diversity of weights and measures among provincial districts of Great Britain and Ireland, are now seen and felt more than ever, because mutual intercourse has increased. Great nations are the world's provinces, and among them also intercourse is rapidly extending. Each people has peculiarities; some of which, were it even possible, it would perhaps not be desirable to change; but there are certain traits of mental as well as of physical character which are common to all alike. The idea of establishing a universal system of coins, weights, and measures is suggested by the notions of the fundamental nature of numbers and quantity possessed in common by all mankind. If several nations separately find themselves induced to adopt metrical systems identical in numerical arrangements, why not make them identical in all respects? That metrical system, whose origin and history has been briefly sketched in the foregoing pages, appears to present all the characters of universality that would adapt it for general use among mankind. **should not be delayed.**

It seems impossible to conceive any mode in which the French metrical system could be improved, except perhaps by some modification of the standards on which it is based. Should this appear desirable in other countries, where the tendency towards its adoption is growing, why not propose some readjustment of the question of standards?

The plenipotentiaries of the great powers of Europe have often met to debate over the settlement of a frontier, which would determine the temporary disposal of a few square leagues of territory: would it less become an assembly of the representatives of nations to finally concur in an arrangement that would give equal advantages to all, and by which misunderstandings between countries as well as between individuals would be rendered probably less frequent, and certainly less complicated? **The adoption of the French system might be settled by plenipotentiaries.**

HENRY HENNESSY.

The International Association for obtaining a uniform decimal system of measures, weights, and coins, has published a comprehensive essay, by Mr. Yates, on the best unit of length, which was received just when the foregoing article was about to be printed off. It is therefore briefly noticed under the head of *Scientific Notices.*

ART. IV.—*On the formula*, μία φύσις τοῦ θεοῦ λόγου σεσαρκωμένη. *By* VERY REV. J. H. NEWMAN, D.D.

§ 1.

THIS celebrated formula of St. Cyril's, perhaps of St. Athanasius's, was, as is well known, one of the main defences of Eutyches, the patriarch of the Monophysites, in controversy with Catholics. It has been so fully discussed by theologians from his day to our own, that it hardly allows of any explanation, which would be at once original and true; still room is left for collateral illustration and remarks in detail; and so much shall be attempted here.

The inquiry

First of all, and in as few words as possible, and *ex abundanti cautelâ:*—Every Catholic holds that the Christian dogmas were in the Church from the time of the Apostles; that they were ever in their substance what they are now; that they existed before the formulas were publicly adopted, in which, as time went on, they were defined and recorded; and that such formulas, when sanctioned by the due ecclesiastical acts, are binding on the faith of Catholics, and have a dogmatic authority. With this profession once for all, I put the strictly theological question aside; for I am concerned in a purely historical investigation into the use and fortunes of certain scientific terms.

turns upon the use of terms.

§ 2.

Phraseology of Science gradually perfected,

Even before we take into account the effect which would naturally be produced on the first Christians by the novelty and mysteriousness of doctrines which depend for their reception simply upon Revelation, we have reason to anticipate that there would be difficulties and mistakes in expressing them, when they first came to be set forth by unauthoritative writers. Even in secular sciences, inaccuracy of thought and language is but gradually corrected; that is, in proportion as their subject-matter is thoroughly scrutinized and mastered by the co-operation of many independent intellects, successively engaged upon it. Thus, for instance, the word *Person* requires the rejection of various popular senses, and a

careful definition, before it can serve for philosophical uses. We sometimes use it for an *individual* as contrasted with a class or multitude, as when we speak of having "personal objections" to another; sometimes for the *body*, in contrast to the soul, as when we speak of "beauty of person". We sometimes use it in the abstract, as when we speak of another as "insignificant in person"; sometimes in the concrete, as when we call him "an insignificant person". How divergent in meaning are the derivatives, *personable*, *personalities*, *personify*, *personation*, *personage*, *parsonage!* This variety arises partly from our own carelessness, partly from the neccssary developments of language, partly from the exuberance of human thought, partly from the defects of our vernacular tongue.

Language then requires to be refashioned even for sciences which are based on the senses and the reason; but much more will this be the case, when we are concerned with subject-matters, of which, in our present state, we cannot possibly form any complete or consistent conception, such as the Catholic doctrines of the Trinity and Incarnation. Since they are from the nature of the case above our intellectual reach, and were unknown till the preaching of Christianity, they required on their first promulgation new words, or words used in new senses, for their due enunciation; and, since these were not definitely supplied by Scripture or by tradition, nor for centuries by ecclesiastical authority, variety in the use, and confusion in the apprehension of them, were unavoidable in the interval. This conclusion is necessary, admitting the premisses, antecedently to particular instances in proof.

especially in the province of revelation.

Moreover, there is a presumption equally strong, that the variety and confusion that I have anticipated, would in matter of fact issue here or there in actual heterodoxy, as often as the language of theologians was misunderstood by hearers or readers, and deductions were made from it which the teacher did not intend. Thus, for instance, the word *Person*, used in the doctrine of the Holy Trinity, would on first hearing suggest Tritheism to one who made the word synonymous with *individual;* and Unitarianism to another, who accepted it in the classical sense of a *mask* or *character*.

Mistakes during the process.

Even to this day our theological language is wanting in accuracy: thus, we sometimes speak of the controversies concerning the *Person* of Christ, when we mean to in-

clude in them those which belong to the two *natures* which are predicated of him.

§ 3.

Reluctance of early Catholics to pursue it

Indeed, the difficulties of forming a theological phraseology for the whole of Christendom were obviously so great, that we need not wonder at the reluctance which the first age of Catholic divines showed in attempting it, even apart from the obstacles caused by the distraction and isolation of the churches in times of persecution. Not only had the words to be adjusted and explained which were peculiar to different schools or traditional in different places, but there was the formidable necessity of creating a common measure between two, or rather three languages,—Latin, Greek, and Syriac. The intellect had to be satisfied, error had to be successfully excluded, parties the most contrary to each other, and the most obstinate, had to be convinced. The very confidence which would be felt by Christians in general that Apostolic truth would never fail,—and that they held it in each locality themselves and the *orbis terrarum* with them, in spite of all verbal contrarieties,—would indispose them to define it, till definition became an imperative duty.

illustrated by the *Homousion*,

I think this plain from the nature of the case; and history confirms me in the instance of the celebrated word ὁμοούσιον, which, as one of the first and most necessary steps, so again was apparently one of the most discouraging, in giving a scientific expression to doctrine. This formula, as Athanasius, Hilary, and Basil affirm, had been disowned as savouring of heterodoxy by the great Council of Antioch in A.D. 269; yet, in spite of this disavowal on the part of Bishops of the highest authority, it was imposed on all the faithful to the end of time in the Ecumenical Council of Nicæa, A.D. 325, as the one and only safeguard, as it really is, of orthodox teaching. The misapprehensions and protests which, after such antecedents, its adoption occasioned for many years may be easily imagined. Though above three hundred Bishops had accepted it at Nicæa, the great body of the Episcopate in the next generation considered it inexpedient; and Athanasius himself, whose imperishable name is bound up with it, showed himself most cautious in putting it forward, though he knew it had the sanction of a General Council. He mentions the word, I think, only once in his three celebrated

Orations, and then rather in a formal statement of doctrine than in the flow of his discussion, viz., *Orat.* i. 4. Twice he gives utterance to it in the Collection of Notes which make up what is called his fourth Oration (*Orat.* iv. 9, 12). He introduces it indeed into his *de Decretis Nic. Conc.* and his *de Synodis;* but there it constitutes his direct subject, and he discusses it in order, when challenged, to defend it. And in his work against Apollinaris he says ὁμοούσιος ἡ τριάς, i. 9. But there are passages of his Orations in which he omits it, when it was the natural word to use; *vid.* my notes on *Orat.* i. 20, 21, and 58 fin. Moreover, the word does not occur in the *Catecheses* of St. Cyril of Jerusalem, A.D. 347, nor in the recantation made before Pope Julius by Ursacius and Valens, A.D. 349, nor in the cross-questionings to which St. Ambrose subjected Palladius and Secundianus, A.D. 381. At Seleucia, A.D. 359, as many as 150 Eastern Bishops were found to abandon it, while at Ariminium in the same year the celebrated scene took place of 400 Bishops of the West being worried and tricked into a momentary act of the same character. They had not yet got it deeply fixed into their minds, as a sort of first principle, that to abandon the formula was to betray the faith. We may think how strong and general the indisposition was thus to regard the matter, when no less a man than Athanasius believed the report that Pope Liberius had given it up (*vid. Histor. Arian.* 41 fin).

This disinclination to dogmatic definitions was not confined to the instance of the ὁμοούσιον. It was one of the successful stratagems of the Arians to urge upon Catholics the propriety of confining their statement of doctrine to the language of Scripture, and of rejecting ὑπόστασις, οὐσία, and similar terms, which, when once used in a definite sense, that is, scientifically, in Christian teaching, would become the protection and record of orthodoxy. **and by other terms,**

In the instance of the word ὑπόστασις, we find Athanasius, Eusebius of Vercellæ, and other Catholic Confessors of the day, recognizing and allowing the two acceptations, in which at that time it was used, in the Alexandrian Council, A.D. 362. **especially the** ***the hypostasis;***

§ 4.

Such a reluctance to fix the phraseology of doctrine cannot be logically taken to imply an indisposition to- **yet this no proof**

of carelessness about dogma.

wards dogma itself; and in matter of fact it is historically contemporaneous with the most unequivocal dogmatic statements. Scientific terms are not the only token of science. Distinction or antithesis is as much a characteristic of it, as definition can be, though not so perfect an instrument. The Epistles of Ignatius, for instance, who belongs to the Apostolical age of the Church, are in places unmistakeably dogmatic. Such is the fragment preserved by Athanasius (*de Syn.* 47): Εἷς ἰατρός ἐστι σαρκικός καὶ πνευματικὸς, γεννητὸς καὶ ἀγέννητος, ἐν ἀνθρώπῳ θεὸς, ἐν θανάτῳ ζωὴ ἀληθινὴ, καὶ ἐκ Μαρίας καὶ ἐκ θεοῦ. I have been led to refer to a number of similar passages, though with another object, in some Latin Dissertations which I published in Rome in 1847, pp. 32–34; but the subject would admit of large illustration. From this small work I extract a sentence, which is apposite to the point immediately before us: "Quis dubitet sanctissimos viros in gravissimâ materie Catholicas enunciasse sententias? Sed aliud est loqui Catholicè, prorsus aliud uti iis ipsis vocabulis, quæ Catholici hoc tempore utuntur, quæ quidem non erant necessaria, non erant in ecclesiastico usu, donec irrepsisset hæreticorum fraus, donec periclitaretur fidelium salus" (p. 36).

Athanasius dogmatic, though without science.

Indeed no better illustration can be given of that intrinsic independence of a fixed terminology which belongs to the Catholic Creed, than the writings of Athanasius himself, the special doctor from whom the subsequent treatises of Basil, the two Gregories, and Cyril are derived. This remarkable author scarcely uses any of the scientific phrases which have since been received in the Church and have become dogmatic; or, if he introduces them, it is to give them senses which have long been superseded. A good instance of his manner is afforded by the long passage—Orat. iii. 30–58, which is full of theology, with scarcely a dogmatic word. The case is the same with his treatment of the Incarnation. No one surely can read his works without being struck with the force and exactness with which he lays down the outlines and fills up the details of the Catholic dogma, as it has been defined since the controversies with Nestorius and Eutyches, who lived in the following century; yet the word θεοτόκος, which had come down to him, like ομοούσιος, by tradition, is nearly the only one among those which he uses, which would now be recognized as dogmatic.

§ 5.

Sometimes too he varies the use which he makes of such terms as really are of a scientific character. An instance of this is supplied by *hypostasis*, a word to which allusion has already been made. It was usual, at least in the West and in St. Athanasius's day, to speak of one *hypostasis*, as of one *usia*, of the Divine Nature. Thus the so-called Sardican Creed, A.D. 347, speaks of *μία ὑπόστασις, ἣν αὐτοὶ οἱ αἱρετικοὶ ουσίαν προσαγορεύουσι.* Theod. Hist. ii. 8; the Roman Council under Damasus, A.D. 371, says that the Three Persons are *τῆς αὐτῆς ὑποστάσεως καὶ οὐσίας*; and the Nicene Anathema condemns those who say that the Son *ἐγένετο ἐξ ἑτέρας ὑποστάσεως ἢ οὐσίας*; for that the words are synonymes I have argued, after Petavius, against Bull in one of the Dissertations to which I have already referred. Epiphanius too speaks of *μία ὑπόστασις*. *Hær*. 74, 4 *Ancor*. 6 (and though he has *αἱ ὑποστάσεις*, *Hær*. 62, 3. 72, 1, yet he is shy of the plural, and prefers *πατὴρ ἐνυπόστατος, υἱός ἐνυπόστατος*, etc., *ibid*. 3 and 4. *Ancor*. 6, and *τρία* as *Hær*. 74, 4, where he says *τρία ἐνυπόστατα τῆς αὐτῆς ὑποστάσεως*. Vid. also *ἐν ὑποστάσει τελειότητος*. *Hær*. 74, 12, *Ancor*. 7 *et alibi*); and Cyril of Jerusalem of the *μονοειδὴς ὑπόστασις* of God. *Catech*. vi. 7, *vid*. also xvi. 12 and xvii. 9 (though the word may be construed one out of three in *Cat*. xi. 3), and Gregory Nanzianzen *Orat*. 28, 9, where he is speaking as a natural, not as a Christian theologian.

His varying application of hypostasis.

One hypostasis taught in 4th century,

In the preceding century Gregory Thaumaturgus had laid it down that the Father and Son were *ὑποστάσει ἕν*; and the Council of Antioch, A.D. 364–369, calls the Son *οὐσίᾳ καὶ ὑποστάσει θεὸν θεοῦ υἱὸν*. Routh *Reliq*. t. 2, p. 466. Accordingly Athanasius expressly tells us, "*Hypostasis* is *usia*, and means nothing else but *αὐτὸ τὸ ὄν* ad Afros. 4. Jerome says that "Tota sæcularium litterarum schola nihil aliud *hypostasin* nisi *usiam* novit". *Epist*. xv. 4. Basil, the semi-Arian, that "the Fathers have called *hypostasis usia*". Epiph. *Hær*. 73, 12, fin. And Socrates says that at least it was frequently used for *usia*, when it had entered into the philosophical schools. *Hist*. iii. 7.

and in 3rd century.

On the other hand the Alexandrians, Origen (*in Joan*. ii. 6 *et alibi*), Ammonius (*ap. Caten. in Joan*. x. 30, if genuine), Dionysius (*ap*. Basil *de Sp. S*. n. 72), and Alex-

Three by Alexandrians.

ander (*ap*. Theod. *Hist*. i. 4), speak of more *hypostases* than one in the Divine Nature, that is, of three; and apparently without the support of the divines of any other school, unless Eusebius, who is half an Alexandrian, be an exception. Going down beyond the middle of the fourth century and the Council of 362 above referred to, we find the Alexandrian Didymus committing himself to a bold and strong enunciation of the Three *hypostases*, which is without a parallel, I think, in patristical literature.

Both one and three by Athanasius, It is remarkable that Athanasius should so far innovate on the custom of his own Church, as to use the word in each of these two applications of it. In his *In illud Omnia* he speaks of τὰς τρεῖς ὑποστάσεις τελείας. He says, μία ἡ θεότης, καὶ εἷς θεὸς ἐν τρισὶν ὑποστάσεσι, *Incarn. c. Arian.* if the work be genuine. In *contr. Apoll.* i. 12, he seems to contrast οὐσία and φύσις with ὑπόστασις, saying τὸ ὁμοούσιον ἕνωσιν καθ' ὑπόστασιν οὐκ ἐπιδεχόμενόν ἐστι, ἀλλὰ κατὰ φύσιν. Parallel instances occur in *Expos. Fid.* 2, and in *Orat.* iv. 25, though the words may be otherwise explained. On the other hand, he makes *usia* and *hypostasis* synonymous in *Orat.* iii. 65, 66. *Orat.* iv. 1 and 33 fin. Vid. also *Quod Unus est Christus*, and the fragment in Euthym. *Panopl.* p. 1, t. 9; the genuineness of both being more than doubtful.

who innovates on the Alexandrian usage, There is something more remarkable still in this innovation, in which Athanasius permits himself, on the practice of his Church. Alexander, his immediate predecessor and master, published, A.D. 320-324, two formal letters against Arius, one addressed to his namesake of Constantinople, the other encyclical. It is scarcely possible to doubt that the latter was written by Athanasius; it is so unlike the former in style and diction, so like the writings of Athanasius. Now it is observable that in the former the word *hypostasis* occurs in its Alexandrian sense at least five times; in the latter, which I attribute to Athanasius, it is dropt, and *usia* is introduced, which is absent from the former. That is, Athanasius has, on this supposition, when writing in his Bishop's name a formal document, pointedly innovated on his Bishop's theological language, and that the received language of his own Church. I am not supposing he did this without Alexander's sanction. Indeed the character of the Arian polemic would naturally lead Alexander, as well as Athanasius, to be jealous of the formula of the τρεῖς ὑποστάσεις, which Arianism was using against them; and the

latter would be confirmed in this feeling by his subsequent familiarity with Latin theology, and the usage of the Holy See, which, under Pope Damasus, as we have seen, A.D. 371, spoke of one *hypostasis*, and in the previous century, A.D. 260, protested by anticipation in the person of Pope Dionysius against the use which might be made, in the hands of enemies, of the formula of the three *hypostases*. Still it is undeniable that Athanasius does at least once speak of three, though his practice is to dispense with the word and to use others instead of it.

Yet it is difficult to believe that so accurate a thinker as Athanasius really used an important term in two distinct, nay contrasted senses; and I cannot but question the fact, so commonly taken for granted, that the divines of the beginning of the fourth century had appropriated any word whatever definitely to express either the idea of *Person* as contrasted with that of *Essence*, or of *Essence* as contrasted with *Person*. I altogether doubt whether we are correct in saying that they meant by *hypostasis*, in one country *Person*, in another *Essence*. I think such propositions should be carefully proved, instead of being taken for granted, as at present is the case. Meanwhile, I have an hypothesis of my own. I think they used the word in East and West with only such a slight variation in its meaning, as would admit of Athanasius speaking of one *hypostasis* or three, without any great violence to that meaning, which remained substantially one and the same. What this sense is I proceed to explain:— **yet without changing the general sense of the term,**

§ 6.

The schoolmen are known to have insisted with great earnestness on the numerical unity of the Divine Being; each of the three Divine Persons being one and the same God, unicus, singularis, et totus Deus. In this, however, they did but follow the recorded doctrine of the Western theologians of the fifth century, as I suppose will be allowed by critics generally. So forcible is St. Austin upon the strict unity of God, that he even thinks it necessary to caution his readers against supposing that he could allow them to speak of One Person as well as of Three in the Divine Nature, de Trin., vii. 11. Again, in the Creed *Quicunque*, the same elementary truth is emphatically insisted on. The neuter *unum* of former divines is changed into the masculine, in enunciating the mystery. "Non **which denotes the one Supreme Being.**

tres æterni, sed unus æternus". I suppose this means, that each Divine Person is to be received as the one God as entirely and absolutely as he would be held to be, if we had never heard of the other Two, and that he is not in any respect less than the one and only God, because they are each that same one God also; or in other words, that, as each human individual being has one personality, the Divine Being has three.

as individual, personal, Returning then to Athanasius, I consider that this same mystery is implied in his twofold application of the word *hypostasis*. The polytheism and pantheism of the heathen world imagined,—not even the God whom natural reason can discover, conceive, and worship, one, individual, living, and personal,—but a *divinitas*, which was either a quality, whether energy or life, or an extended substance, or something else equally inadequate to the real idea which the word conveys. Such a divinity could not properly be called an *hypostasis* or said to be *in hypostasi* (except indeed as brute matter may be called, as in one sense it can be called, an *hypostasis*), and therefore it was, that that word had some fitness, especially after the Apostle's adoption of it, *Hebr*. i. 3, to denote the Christian's God. And this may account for the remark of Socrates, that it was a new word, strange to the schools of ancient philosophy, which had seldom professed pure theism, or natural theology. "The teachers of philosophy among the Greeks", he says, "have defined *usia* in many ways: but of *hypostasis*, they have made no mention at all. Irenæus, the grammarian, affirms that the word is barbarous".—*Hist*. iii. 7. The better then was it fitted to express that highest object of thought, of which the "barbarians" of Palestine had been the special witnesses. When the divine *hypostasis* was confessed, the word expressed or suggested the attributes of individuality, self-subsistence, self-action, and personality, such as go to form the idea of the Divine Being to the natural theologian; and, since the difference between the theist and the Catholic divine in their idea of his nature is simply this, that, in opposition to the Pantheist, who cannot understand how the Infinite can be Personal at all, the one ascribes to him one personality, and the other three, it will be easily seen how a word, thus characterised and circumstanced, would admit of being used with but a slight modification of its sense, of the Trinity as well as of the Unity.

as the God of natural theology,

Let us take, by way of illustration, the word μονὰς

and also as being any and each of the Three Persons of the Holy Trinity.

which, when applied to intellectual beings, includes the idea of personality. Dionysius of Alexandria, for instance, speaks of the *μονὰς* and the *τριὰς*: now, would it be very harsh, if, as he has spoken of "three *hypostases*" *ἐν μονάδι*, so he had instead spoken of "the three *μονάδες*", that is, in the sense of *τρισυπόστατος μονὰς*, as if the intrinsic force of the word *monas* would preclude the possibility of his use of the plural *μονάδες* being mistaken to imply that he held more *monades* than one? To take an analogous case, it would be about the same improper use of plural for singular, if we said that a martyr by his one act gained three victories, instead of a triple victory, over his three spiritual foes. This then is what I conceive that Athanasius means, by sometimes speaking of one, sometimes of three *hypostases*. The word *hypostasis* neither means *Person* nor *Essence* exclusively; but it means the one personal God of natural theology, the notion of whom the Catholic corrects and completes as often as he views him as a Trinity; of which correction Nazianzen's language, *supra p.* 335, contrasted with his usual formula (*vid. Orat.* 20, 6) of the three *hypostases*, is an illustration. The specification of three *hypostases* does not substantially alter the sense of the word itself, but is a sort of *catachresis* by which this Catholic doctrine is forcibly brought out (as it would be by the phrase "three monades"), viz., that each of the Divine Persons is simply the Unus et Singularis Deus. If it be objected, that by the same mode of reasoning, Athanasius might have said *catachrestically* not only three *monades* or three *hypostases*, but three Gods, I deny it, and for this reason, because *hypostasis* is not equivalent to the simple idea of God, but is rather a definition of Him, and that in some special elementary points, as essence, personality, etc., and because such a mere improper use or varying application of the term would not tend to compromise a truth, which never must even in forms of speech be trifled with, the absolute numerical unity of the Supreme Being. Though a Catholic could not say that there are three Gods, he could say, that the definition of God applies to *unus* and *tres*. Perhaps it is for this reason that Epiphanius speaks of *τρία ἐνυπόστατα, συνυπόστατα, τῆς αὐτῆς ὑποστάσεως*. *Hær.* 74, 4 (*vid.* Jerome, *Ep.* 15, 3), in the spirit in which St. Thomas, I believe, interprets the "non tres æterni, sed unus æternus", to turn on the contrast of adjective and substantive.

Latitude in the sense of the term

Petavius makes a remark which is apposite to my present purpose. "Nomen Dei", he says, *de Trin.* iii. 9, § 10, "cùm sit ex eorum genere quæ concreta dicuntur, formam significat, non abstractam ab individuis proprietatibus, sed in iis subsistentem. Est enim Deus substantia aliqua divinitatem habens. Sicut homo non humanam naturam separatam, sed in aliquo individuo subsistentem exponit, ita tamen ut individuum ac personam, non certam ac determinatam, sed confuse infiniteque representet, hoc est, *naturam in aliquo*, ut diximus, *consistentem* . . . sic nomen Dei propriè ac directe divinitatem naturamque divinam indicat, *assignificat autem eundem, ut in quâpiam personâ subsistentem, nullam de tribus expresse designans, sed confuse et universe*". Here this great author seems to say, that even the word "Deus" may stand, not barely for the Divine Being, but besides "in quâpiam personâ subsistentem", without denoting *which* Person; and in like manner I would understand *hypostasis* to mean the *monas* with a like undeterminate notion of personality, (without which attribute the idea of God cannot be,) and thus, according as one *hypostasis* is spoken of, or three, the word may be roughly translated, in one case "personal substance", or "being with personality", in the other "substantial person", or "person which is in being". In all cases it will be equivalent to the θεότης, the μονὰς, the divine οὐσία, etc., though with that peculiarity of meaning which I have insisted on.

Illustrated from Athanasius, etc.

These remarks might be illustrated by a number of passages from Athanasius, in which he certainly implies that the μονὰς, that is, the indivisible, numerically one God, is at once Father and Son; that the Father, who is the μονὰς, gives to the Son also to be the μονὰς; and to have his (the Father's) *hypostasis*, *i.e.* to be that *hypostasis*, which the Father is. For instance, he says that the μονὰς θεότητος is ἀδιαίρετος, though Father and Son are two;—*Orat.* iv. 1, 2. He speaks of the ταὐτότης τῆς θεότητος, and the ἑνότης τῆς οὐσίας, *Orat.* iii. 3; of the ἑνότης τῆς ὁμοιώσεως. *de Syn.* 45; of the ταὐτότης τοῦ φωτός, *de Decr.* 24; of "the Father's *hypostasis* being ascribed to the Son", *Orat.* iv. 33; of the πατρικὴ θεότης being τὸ εἶναι τοῦ υἱοῦ, *Orat.* iii. 3; of the εἶναι το υἱοῦ being τῆς τοῦ πατρὸς οὐσίας ἴδιον. *ibid.*, of the Son being the πατρικὴ ἰδιότης, *Orat.* i. 42; of the Father's θεότης being in the Son, *de Syn.* 52 (whereas the Arians made the two θεότητες different in kind); of the Son's θεότης being the

Father's, *Orat.* iii. 36; of the Son's πατρικὴ θεότης. *Orat.* i. 45, 49; ii. 18, 73; iii. 26, of the Son's πατρικῆ φύσις, *Orat.* i. 40; of the Son being τὸ πατρικὸν φῶς, iii. 53; and of the Son being the πλήρωμα τῆς θεότητος. *Orat.* iii. i. *Vid.* also Didym. *Trin.* i., 15 p. 27, 16 p. 41, 18 p. 45, 27 p. 80. iii., 17 p. 377, 23 p. 409; Nyss. *Test. c. Jud.* i. p. 292; Cyril *c. Nest.* iii. p. 80, b.

§ 7.

Since, as has been said above, *hypostasis* is a word more peculiarly Christian than *usia*, I have judged it best to speak of it first, that the meaning of it, as it is ascertained on inquiry, may serve as a key for explaining other parallel terms. *Usia* is one of these the most in use, certainly in the works of Athanasius, and we have his authority as well as St. Jerome's for stating that it had been simply synonymous with *hypostasis*. Moreover, in *Orat.* iii. 65, he uses the two words as equivalent to each other. If this be so, what has been said above, in explanation of the sense he put on the word *hypostasis*, will apply to *usia* also. This conclusion is corroborated by the proper meaning of the word *usia* itself, which answers to the English word "being". Now, when we speak of the Divine Being, we mean to speak of Him, as what he is, ὁ ὢν, including generally his attributes and characteristics, and among them, at least obscurely, his personality. By the "Divine *Being*" we do not commonly mean a mere *anima mundi*, or first principle of life, or system of laws. *Usia* then, thus considered, agrees very nearly in sense, from its very etymology, with *hypostasis*. Further, this was the sense in which Aristotle used it, viz. for what is "individuum", and "numero unum"; and it must not be forgotten that the Neo-platonists, who exerted so great an influence on the Alexandrian Church, professed the Aristotelic logic. Nay to St. Cyril himself, the successor of Athanasius, whose formula these remarks are intended to illustrate, is ascribed a definition, which makes *usia* to be an individual essence: οὐσία, πρᾶγμα αὐθύπαρκτον, μὴ δεόμενον ἑτέρου πρὸς τὴν ἑαυτοῦ σύστασιν; *vid.* Suicer. *Thes. in voce.* — *Usia* has a like meaning,

This is the word, and not *hypostasis*, which Athanasius commonly uses, in controversy with the Arians, to express the divinity of the Word. In one passage alone, as far as I recollect, does he use *hypostasis:* οὐ τὴν ὑπόσ- — and is preferred by Athanasius

τασιν χωρίζων τοῦ θεοῦ λόγου ἀπὸ τοῦ ἐκ Μαρίας ἀνθρώπου. *Orat.* iv. 35. His usual term is *usia*:—for instance, *τὴν θεῖαν οὐσίαν τοῦ λόγου ἡνωμένον φύσει τῷ ἑαυτοῦ πατρί. In Illud, Omnia*, 4. Again, *ἡ οὐσία αὕτη τῆς οὐσίας τῆς πατρικῆς ἐστί γεννημα. de Syn.* 48;—two remarkable passages, which remind us of the two *οὐσίαι* and two *φύσεις*, used by the Alexandrian Pierius (Phot. *cod.* 119), and of the words of Theognostus, another Alexandrian, *ἡ τοῦ υἱοῦ ὀυσία ἐκ τῆς τοῦ πατρὸς οὐσίας ἔφυ. ap.* Athan. *de Decr. Nic.* c. 25. Other instances of the *usia* of the Word in Athanasius are such as the following, though there are many more than can be enumerated:—*Orat.* i, 10, 45, 57, 59, 62, 64 fin.; ii., 7, 9, 11, 12, 13, 18, 22, 47, 56.

as a synonyme for *hypostasis* In all these instances *usia*, I conceive, is substantially equivalent to *hypostasis*, as I have explained it, viz., expressing the divine *μονὰς* with an obscure intimation of personality inclusively; and here I think I am able to quote the words of Father Passaglia, as agreeing (so far) in what I have said. "Quum *hypostasis*", he says, *de Trinitate*, p. 1302, "esse nequeat sine substantiâ, nihil vetabat quominus trium hypostasum defensores *hypostasim* interdum pro substantiâ sumerent, præsertim ubi *hypostasis* opponitur rei non subsistenti ac efficientiæ". I should wish to complete the admission by adding, "Since an intellectual *usia* naturally implies an *hypostasis*, there was nothing to hinder *usia* being used, when *hypostasis* had to be expressed". Nor can I construe *usia* in any other way in the two passages from *In Illud, Omnia*, 4, and *de Syn.* 48, quoted above, to which may be added *Orat.* ii. 47, *init.*, where Athanasius speaks of the Word as *τὴν οὐσίαν ἑαυτοῦ γινώσκων μονογενῆ σοφίαν καὶ γέννημα τοῦ πάτρος.* Again he says, *Orat.* iv. 1, that he is *ἐξ οὐσίας οὐσιώδης καὶ ἐνούσιος, ἐξ ὄντος ὤν.*

If we want a later instance, and from another school, of *usia* and *hypostasis* being taken as practically synonymous, when contrasted with the *economia*, we may find one in Nyssen *c. Eunom. Orat.* v. p. 169.

§ 8.

and *physis* also, After what I have said of *usia* and *hypostasis*, it will not surprise the reader if I consider that *physis* also, in the Alexandrian theology, was equally capable of being applied to the Divine Being viewed as one, or viewed as three, or as each of the three separately. Thus Athana-

sius says, μία ἡ θεία φύσις. *contr. Apoll.* ii. 13 *fin. de Incarn. V.* fin. Alexander, on the other hand, calls the Father and Son τὰς τῇ ὑποστάσει δύο φύσεις, (as Pierius, to whom I have already referred, uses the word), Theod. *Hist.* i. 4; and so Clement, also of the Alexandrian school, ἡ υἱοῦ φύσις ἡ τῷ μόνῳ παντοκράτορι προσεχεστάτη, *Strom.* vii. 2. In the same epistle Alexander speaks of the μεσιτεύουσα φύσις μονογενὴς; and Cyril, *in Thesaur.* xi. p. 85, speaks of ἡ γέννησας φύσις, and ἡ γεννηθεῖσα ἐξ αὐτῆς. In like manner Athanasius speaks of the φύσις of the Son being less divisible from the Father than the radiance from the sun, *de Syn.* 52. *Vid.* also *Orat.* i. 51. In corroboration of this view of the word φύσις I may refer to Cyril himself. The φύσις τοῦ λόγου, he says, signifies neither *hypostasis* alone, nor what is common to the *hypostases*, but τὴν κοίνην φύσιν ἐν τῇ τοῦ λόγου ὑποστάσει ὁλικῶς θεωρουμένην. *ap.* Damasc. F. O. iii. 11. And thus Didymus speaks of the ἀναλλοίωτος φύσις ἐν ταὐτότητι τῶν προσώπων ἑστῶσα. *Trin.* i. 9.

Εἶδος is a word of a similar character. As it is found in *John*, v. 37, it may be interpreted of the divine essence or of person; the Vulgate translates "neque *speciem* ejus vidistis". In Athan. *Orat.* iii. 3, it is synonymous with θεότης or *usia;* as *ibid.* 6 also; and apparently in *ibid.* 16, where the Son is said to have the εἶδος of the Father. And so in *de Syn.* 52. Athanasius says that there is only one εἶδος θεότητος. Yet, as taken from *Gen.*, xxxii. 31, it is considered to denote the Son; *e.g.* Athan. *Orat.* i. 20, where it is used as synonymous with Image, εἴκων. In like manner he is called "the very εἶδος τῆς θεότητος. *Ep. Æg.* 17. But again in Athan. *Orat.* iii. 6, it is first said that the εἶδος of the Father and Son are one and the same, then that the Son is the εἶδος of the Father's θεότης, and then that the Son is the εἶδος of the Father. and εἶδος.

§ 9.

So much on the sense of the words οὐσία, ὑπόστασις, φύσις, and εἶδος, among the Alexandrians of the fourth and fifth centuries, as denoting fully and absolutely all that the natural theologian attaches to the notion of the Divine Being,—as denoting the God of natural theology, with only such variation of sense in particular passages as the context determines, and as takes place when we say, "God of heaven", "God of our fathers", "God of These terms inapplicable in their full sense to the Word's humanity,

armies", "God of peace"; (all of which epithets, as much as "one" or "three", bring out respectively different aspects of one and the same idea,) and, when applied to the second Person of the Blessed Trinity, meaning simply that same Divine Being, Deus singularis et unicus, in personâ Filii. Now then the question follows, which brings us at once upon the formula, which I have proposed to illustrate; viz., since the Word is an οὐσία, ὑπόστασις, or φύσις, can the man, ἄνθρωπος,—manhood, humanity, human nature, flesh,—which he assumed, be designated by these three terms in a parallel full sense, as meaning that he became all that "a human being" is, man with all the attributes and characteristics of man? Was the Word a man in the precise and unrestricted sense in which any one of us is a man? The formula denies it, for it calls him μία φύσις σεσαρκωμένη, not δύο φύσεις; and in the sense which I have been ascribing to those three terms, it rightly denies it; for in the sense in which the Divine Being is an *usia*, etc., his human nature is not an *usia*, etc.; so that in *that* sense there are not two φύσεις, but one only, and there could not be said to be two without serious prejudice to the Catholic dogma.

§ 10.

yet they are so applied, I have said, "in the sense in which the Divine Being is an *usia*"; for doubtless this and the other terms in question are not always to be taken in the sense which attaches to them in the above passages.

e. g. Hypostasis. 1. *Hypostasis*, for instance, is used for substance as opposed to appearance or imagination, in *Hebr.*, xi. 1. And in like manner Epiphanius speaks of the σαρκὸς ὑπόστασιν ἀληθινήν. *Hær.* 69, 59. And Irenæus, of "substantia carnis", *Hær.* iii. 22, which doubtless was in the original *hypostasis*, as is shown by the οὐ δοκήσει, ἀλλ' ὑποστάσει ἀληθείας, *ibid.* v. i. In a like sense Cyril of Jerusalem seems to use the word, *Cat.* vii. 3, ix. 5, 6, x. 2. And Gregory Nyssen, *Antirrh.* 25, *fin.* and apparently in the abstract for existence, *c. Jud.* p. 291. And Cyril of Alexandria, whose formula is in question, in his controversy with Theodoret. Σύστασις is used for it by Athan. *c. Apoll.* i. 5, ii. 5, 6, etc. *Vid.* also Max. *Opp.* t. 2, p. 303, and Malchion *ap.* Routh. *Rell*, t. 2, p. 484. The two words are brought together in Hippol. *c. Noet.*, 15 *fin.*, (where the word *hypostasis* is virtually denied of the human nature), and in Nyss. *Test. c. Jud.* i. p. 292. Also,

ἡ σαρξ οὐκ ὑπόστασις ἰδιοσύστατος ἐγεγόνει. Damasc. *c. Jacob.* 53. For ἰδιοσύστατος, *vid.* Didym. *Trin.* iii. 23, p. 410. Ephræm. *ap.* Phot. *cod.* 229, p. 785 *fin.* Max. *Opp.* t. 2, pp. 281 and 282.

2. If even *hypostasis* may be found of the Word's humanity, there is more reason to anticipate such an application of the other terms which I have classed with it. Thus as regards *usia:* θεὸς ὢν ὁμοῦ τε καὶ ἄνθρωπος τέλειος ὁ αὐτὸς, τὰς δύο αὐτοῦ οὐσίας ἐπιστώσατο ἡμῖν, says Melito *ap.* Routh. *Rell.* t. 1, p. 115. And Chrysostom, οὐχὶ τὰς οὐσίας συγχέων, *in Psalm.* 44, p. 166; also *in Joann. Hom.* ii. 2. *Vid.* also Basil. in *Eunom.* i. 18. Nyssen, *Antirrh.* 30. Cyril. 2 *ad Succ.* p. 144. But the word (*i.e., substantia*) is more common in this sense in Latin writers:—*e.g.* Tertullian. *de Carn. Christ.* 13, 16, etc. *Præscr.* 51. Novat. *de Trin.* 11. Ambros. *de Fid.* ii. 77. Augustin. *Epist.* 187, 10. Vincent. *Commonit.* 13. Leon. *Epist.* 28, p. 811. As to Alexandrian writers, Origen calls the Word's soul, substantia, *Princip.* ii. 6, n. 3, as Eusebius, νοερὰ οὐσία, *de Const. L.*, p. 536. Petavius quotes, as if from Athanasius, τὸ σῶμα κοινὴν ἔχον τοις πᾶσι τὴν οὐσίαν, *Dogm. Theol.* t. 6, p. 13, but this may be *external* to the union, as ἀπαρχὴν λαβὼν ἐκ τῆς οὐσίας τοῦ ἀνθρώπου, *de Inc. et c. Ar.* 8 fin. **and usia,**

3. The word *physis* has still more authorities in its favour than *usia; e.g.* φύσεις δύο, θεὸς καὶ ἄνθρωπος, Greg. Naz. *Epist.* 101, pp. 85, 87. *Epist.* 102, *Carm. in Laud. Virg. v.* 149, *de Vit. sua*, v. 652, Greg. Nyssen. *c. Apoll.* t. 2, p. 696, *c. Eunom. Orat.* 5, p. 168. *Antirrh.* 27. Amphiloch. *ap.* Theod. *Eran.* i. 66. Chrysostom, *in* I. *Tim. Hom.* 7, 2. Basil. Seleuc. *Orat.* 33, p. 175. And so natura, in Hilar. *Trin.* xi. 3, 14, *in Psalm.* 118, *lit.* 14, 8. *Vid.* also Ambrose, Jerome, Augustine, etc. For other instances, *vid.* Conc. Chalc. *Act.* 2, t. 2, p. 300. Leon. *Epist.* 165. Leont. *c. Nestor. ap.* Canis. t. 1, p. 548. Anastas. *Hodeg.* x. Gelas. *de D.N.* (*in Bibl. P.* 1624) t. 4, p. 423. Flavian and Ephræm *ap.* Phot., pp. 801, 806. And for Alexandrian writers, I do not cite Origen (*e.g.*, *in Matth.* t. 3, pp. 852, 902, t. 4, *Append.*, p. 25, etc.), because we cannot be sure that the word was found in the original Greek. But we have θεὸς ἦν φύσει, καὶ γέγονεν ἄνθρωπος φύσει, Petr. Alex. *ap.* Routh. *Rell.* t. 3, p. 344—346. Ἐν ἑκατέραις ταῖς φύσεσι υἱος τοῦ θεοῦ. Isid. Pelus. *Epist.* i. 405. And Athanasius himself, ἡ μορφὴ τοῦ δούλου is ἡ νοερὰ τῆς ἀνθρώπων συστάσεως φύσις συν τῇ **and physis;**

ὀργανικῇ καταστάσει, *c. Apoll.* ii. 1. *Vid.* also i. 5, ii. 11. *Orat.* ii. 70, iii. 43. Nor must it be forgotten that Cyril himself accepted the two φύσεις; *vid.* some instances at the end of Theod. *Eran.* ii. *Vid.* also *c. Nest.* iii. p. 70, *d. e.* and his Answers to the Orientals and Theodoret.

§ 11.

but not in their full sense,

However, though we could bring together all the instances which antiquity would furnish on the point, still the fact would stand, first, that these terms did not belong to the Word's humanity in the full sense in which they were used of his Divine Nature; secondly, that they are not ordinarily applied to it in any sense by Catholic writers up to the time of Cyril.

especially *physis*,

That they did not apply, especially *physis*, in that full sense in which it belonged to his divinity, will be plain on considering what was said of him in those sacred books, which then, as now, were received in the Church. He differed from the race, out of which he was taken, in many most important respects. (1) He had no human father, *Matt.*, i. 20; *Luke*, i. 34, 35. Gregory Nyssen, with a reference to this doctrine, says, "he was not a man wholly (δι' ὅλου), not a man like others altogether (κοινὸς), but *as* a man". *Antirrh.* 21. (2) He had no human ἡγημονικὸν, or sovereign principle of action in the soul; for if there were two κύρια or ἡγημονικὰ, there were two beings together in him, which is a tenet contrary to the whole tenor of the Gospels, and, when put forth by some early Gnostics, was condemned, as it would seem, by St. John, I. *Epist.*, iv. 3. (3) He was sinless; and, though sin is not part of our nature, yet St. Paul does call us children of wrath, φύσει, *Eph.* ii. 3, which would be a reason for being cautious of applying the term to the Word's humanity; and, though it is true that St. Paul elsewhere speaks of the law of conscience being φύσει, *Rom.* ii. 14, 15, yet St. Jude speaks of a base knowledge being φυσικὸν, also, *v.* 10. (4) We may consider in addition how transcendant was his state of knowledge, sanctity, etc. (5) His body was different *in fact* from ours, as regards corruptibility, as would appear from *Acts*, ii. 31, xiii. 35. (6) It had a life-giving virtue peculiar to itself, *Matt.*, vii. 23; *John*, ix. 6. (7) After the resurrection it had transcendant qualities;—came and vanished; entered a closed room; ascended on high, and

first, on Scripture grounds,

appeared to St. Paul on his conversion, while it was in heaven.

§ 12.

next, on grounds of reason,

But besides this argument from the sacred text, there seemed a necessity from the nature of the case to lay down restrictions, so great, on the sense in which the Word took our common nature, as almost to deprive it of that name. The divine and human could not be united without some infringement upon the one or the other. There were those indeed, who, like some early teachers of the Gnostic family, whom I just now spoke of, and the Nestorians at a later date, escaped from the difficulty by denying the union; but, granting two contraries were to meet in one, how could that union be, without affecting, in its own attributes and state, either the human or the divine? Which side of the alternative was to be followed, is plain without a word; *οὐκ ἐν σώματι ὢν ἐμολύνετο*, says Athanasius, *ἀλλὰ μᾶλλον καὶ τὸ σῶμα ἁγίαζεν*. *Incarn. V.D.* 17. There is a similar passage, Nyssen, *Antirrh.* 26. *τὸν γὰρ ἡμέτερον ῥύπον*, etc. Here we are concerned with the alternative itself. Either the Word must be absorbed into the man, or the man taken up into the Word. The consideration of these opposite conclusions will carry us nearly to the end of our discussion; I shall pursue the separate investigation of them under the letters *a* and *b*.

The divine *physis* must retain its full meaning:

(*a*) The former of these was the conclusion in which resulted the speculations of the Sabellians and Samosatenes, who explained away the "incarnate Word" into a mere divine attribute, virtue, influence, or emanation, which dwelt in the person of one particular man, receiving its perfect development in him, and therefore imperfect before the union, changed in the act of union, dependent on him after the union. Eusebius (whose language, however, is never quite unexceptionable) may be taken as the spokesman of the Catholic body on this point. "The indwelling Word", he says, "though holding familiar intercourse with mortals, did not fall under the sympathy of their affections; nor, after the manner of a man's soul, was fettered down by the body, nor changed for the worse, or came short of his proper divinity"; *de Laud. C.*, p. 536. And then he has recourse to an illustration, common with the Fathers, and expressed by Eustathius of Antioch thus:—"If the sun, which we see with our eyes, undergoes so many indignities, yet without disgrace or

infliction, do we think that the immaterial Wisdom is defiled or changes his nature, though the temple in which he dwells be nailed to the Cross, or suffers dissolution, or sustains a wound, or admits of corruption? No, the temple is affected, but the stainless *usia* remains absolutely in its unpolluted dignity", ap. Theod. *Eran.* iii., p. 237. *Vid.* also Vigil. Taps. *c. Eutych.* ii. p. 503. Anast. *Hodeg.* 12, who are opposing the Apollinarians, Eutychians, etc., who were involved in the same general charge.

therefore the human *physis* must have a restricted meaning.

(*b*) But, on the other hand, if the divinity remains unchanged, change must happen to the humanity; and accordingly, the Fathers are eloquent upon the subject of this change, which from the very nature of the case, and independent of the direct testimony of scripture and tradition, was necessary. To say nothing of the celebrated passages in Nyssen, who has no special connection with the Alexandrian Church, I shall content myself with a passage from Origen: "Si massa aliqua ferri semper in igne sit posita, omnibus suis poris omnibusque venis ignem recipiens, et tota ignis effecta, si neque ignis ab eâ cesset aliquando, neque ipsa ab igne separetur, nunquidnam dicimus hanc . . . posse frigus aliquando recipere? . . . Sicut . . . totam ignem effectam dicimus, quoniam nec aliud in eâ nisi ignis cernitur, sed et si quis . . . affectam tentaverit, *non ferri, sed ignis vim sentiat*, hoc ergo modo, etiam illa anima, quæ, quasi ferrum in igne, sic semper in Verbo, semper in Sapientiâ, semper in Deo posita est, *omne quod agit, quod sentit, quod intelligit, Deus est*, etc. *de Princ.*, ii. 6, n. 6. Hence Isidore, another Alexandrian, says that the Word called himself bread, because he, as it were, baked his human substance "in the fire of his own divinity". *Epist.*, i. 360. Passages from Cyril, Damascene, etc., might be quoted to the same effect, *e. g.* Cyr. *Quod unus*, p. 776. Damasc., *c. Jacob*, p. 409. Hence it was usual with Athanasius and other Fathers to call the incarnation a θέωσις, or θεοποίησις of the ἀνθρώπινον. (vid. Concil. Antioch. *ubi infra* Athan. *de Decr.* 14 fin. *de Syn.* 51. *Orat.*, i. 42, etc., etc.), from the great change which took place in its state, or rather difference in its state, from human nature generally.

§ 13.

How then a *physis* at all?

But, if the humanity assumed was thus *extricated from* the common *usia* or *physis*, to which under other circumstances it would have belonged, and, being grafted upon

the Word, existed from the very first in a *super*natural state, how could it be properly called *nature?* In the words of Damascene, ἡ μεν φύσις τῆς σαρκὸς θεοῦται, οὐ σαρκοῖ δὲ τὴν φύσιν τοῦ λόγου. θεοῖ μὲν τὸ προσλῆμμα, οὐ σαρκοῦται δέ. *c. Jacob*, 52, p. 409. It is but in accordance with this train of thought to lay down that there is only *one* nature in Christ. Here, then, we see the meaning of Cyril's formula.

Hence the force of Cyril's formula. It means (*a*), first, that, when the Divine Word became man, he remained one and the same in essence, attributes, and personality; in all respects the same as before, and therefore *μία φύσις*.

It means (*b*), secondly, that the manhood, on the contrary, which he assumed, was not in all respects the same nature as that *massa*, *usia*, *physis*, etc., out of which it was taken, 1. from the very circumstance that it was but an addition or supplement to what he was already; and 2. because in the act of assuming it, he changed it.

This added nature, then, was best expressed, not by a second substantive, as if collateral in its position, but by an adjective or participle, as σεσαρκωμένη. The three words answered to St. John's, ὁ λόγος σάρξ ἐγένετο.

§ 14.

Illustration from Council of Antioch. We have an apposite illustration of this account of the formula in an early passage of history, as contained in the fragmentary documents which remain to us of the Great Council of Antioch, A.D. 264–269 (to which I have already referred), in which Paul of Samosata was condemned, Malchion being the principal disputant against him. Paul denied that the Divine Being was in Christ in essence or personality; I say "in essence or personality", for, as I have explained above, since the divine essence cannot be without personality, to deny the one was to deny the other, and the further question, whether that personality was single or triple, did not directly come into controversy. By such a doctrine both points of Cyril's subsequent formula were sacrificed:—(*a*) the divine *physis* in Christ was explained away, and (*b*) the σάρξ, being denied its supernatural union, was no longer ὑπερφυὴς, but remained in its strictly natural *usia*, as any other individual of our race, who was in the divine favour. The Synodal Epistle aims at (*a*) the former of these errors; and the fragments of Malchion's disputation (*b*) at the latter.

§ 15.

which enforces the unalterableness of the one divine *usia*,

(*a*) Paul said that the Word was not incarnate as an *usia*, but only as a quality; the Fathers of the Council therefore declare that, on the contrary, he really was an *usia* and *hypostasis* (for they use the terms as equivalent), Routh. *Rell.*, t. 2, p. 466; a ζῶσα ἐνέργεια ἐνυπόστατος, p. 469; the Creator of the universe, p. 468; and Son and God before the creation, p. 466; and that he became incarnate, ἀτρέπτως. Still further to destroy the notion of a separation into two beings, they call this preexisting Word Christ, p. 474, and they assert that he is ἓν καὶ τὸ αὐτὸ τῇ οὐσίᾳ, from first to last, on earth and in heaven. In thus speaking, they are evidently entering a protest against another contemporaneous aspect of the same doctrine, into which even Catholics had, as far as language goes, been betrayed. The opinion I allude to, viz., that of the προφορικὸς λόγος, was that the Word, at first nascent or inchoate, had been perfected by the Incarnation. Not only had Tertullian said, speaking of the "Fiat Lux" at creation, "Hæc est nativitas *perfecta* sermonis", *c. Prax.* 7, but Hippolytus too, that "the Word, before his incarnation and καθ' ἑαυτὸν was not τέλειος υἱὸς, though τέλειος λόγος ὢν μονογενής". *c. Noet.* 15.

together with Catholic doctors generally,

Now all these points, the oneness and identity of the Word in *usia*, his unalterableness in his incarnation, his perfection from eternity, his one sonship, and the criminality of dividing Word and Son, or holding two sons, were traditional matters for Catholic teaching and preaching, against those who imagined some change or other in his nature or state, from the date of this Council, two hundred years before Cyril, down to that of the Council of Chalcedon, after his death, to say nothing of other periods of history. Cyril comes in merely as one instance of the inculcation of this doctrine out of a hundred like him. His peculiarity is his using the term *physis*, for which I have given some reasons already, and shall give more presently.

e.g. Athanasius

All this may be illustrated from Athanasius, who, in controversy not only with Apollinarians, but with teachers of the Samosatene school, had to protest against any *degradation* of the Word's nature, and therefore to maintain his *unity*, his *unchangeableness*, and his *perfection*. "They fall into the same folly as the Arians", he says, "for the Arians say that he was created that he might create; as if God waited till creation, for his *probole* (ἵνα προβάλη-

ται), as these say" (*vid. e. g.* Tertullian above,) "or his creation, as those" (the Arians). He goes on to condemn the notion that ὁ λόγος ἐν τῷ θεῷ ἀτελὴς, γεννηθεὶς, is τέλειος (*vid.* Hippolytus above); "He was not anything, that he is not now, nor is he what he was not" (here is the "one and the same" of the Council above) "otherwise he will have to be *imperfect* and *alterable*. *Orat.* iv. 11, 12. Again: "The world was made by him; if the world is one, and the creation one, it follows that Son and Word are one and the same before all creation, for by him it came into being". 19. "As the Father is one", he says, "so also the μονογενὴς is one". 20. Ταὐτὸν ὁ υἱὸς καὶ λόγος. 29. "Those who separate the divine Word from the divine incarnation conceive that the divine incarnation is an *alteration*, τροπὴ, of the Word; but let a man understand the divine mystery, *one* and *simple*. 32. Again: God's Word is *one and the same;* as God is one, His Image is one, His Word one, and one His Wisdom". *Orat.* ii. 36. Elsewhere he says, "God's Word is not merely προφορικὸς, nor by his Son is meant his command", *e.g.* Fiat lux, "but He is τέλειος ἐκ τελείου. *ibid.* ii. 35. *Vid.* also iii. 52, *Eph. Hær.* 76, p. 945, Hilar. *Trin.* ii. 8. Also Didym. *Trin.* i. 10 *fin.* 20, p. 63, 32. p. 99, iii. 6, p. 357. Nyssen, *Antirrh.* 21 and 56.

So again, αὐτὸς ἄτρεπτος μένων καὶ μη ἀλλοιούμενος ἐν τῇ ἀνθρωπίνῃ οἰκονομίᾳ καὶ τῇ ἐνσάρκῳ παρουσίᾳ. *ibid.* ii. 6. And so against the Apollinarians, *c. Apoll.* ii. 3, 7. And so Pseudo-Athanasius, *ap.* Phot.: "The Word took flesh to fulfil the economy, and not εἰς αὔξησιν οὐσίας". And so, Οὐσία μένουσα ὅπερ ἐστί Chryst. *in Joan. Hom.* xi. 1, Naz. *Orat.* 29. 19. Procl. *ad. Arm.* p. 615. Maxim. *Opp.* t. 2. p. 286. And so, manens id quod erat, factus quod non erat. August. *cons. Ev.* i. 53. *Vid.* also Hilar. *Trin.* iii. 16; Vigil. *c. Eut.* i. And in like manner Leo "*Simplex* et *incommutabilis natura* Deitatis [in Verbo] tota in suâ sit semper essentiâ (*usiâ*), nec damnum sui recipiens aut augmentum, assumptam naturam beatificans. *Epist.* 35. 2. And again, In se incommutabilis perseverans, *deitas* enim, quæ illi cum Pater communis est (*i. e.* ἡ φύσις τοῦ θεοῦ λόγου) nullum detrimentum omnipotentia subiit, (*i. e.* μία ἐστίν) quia summa et sempiterna *essentia*, (*i. e.* οὐσία μία), etc. Leon. *Serm.* 27. 1. and other Fathers,

Moreover, I do not think it a refinement to suggest, that this was one reason why so many of the Fathers interpret *Luke*, i. 35, of the Word, not of the Spirit. It was who therefore attribute the hu-

man γέννησις to the Word. their wish to enforce his personal being and omnipotent life before and in the first beginnings of the economy; as is done by Athanasius by saying λόγος ἐν τῷ πνεύματι ἔπλαττε τὸ σῶμα. *Serap.* 1. 31, and elsewhere by referring to *Prov.* ix. 1; *e. g. Orat.* ii. 44, and so Leo, *Epist.* 31, 2. Thus Irenæus, after insisting on the real existence of both natures, and saying, "if what had existed in truth, οὐκ ἔμεινε πνεῦμα after the incarnation, truth was not in him", proceeds to speak of the *Verbum* Patris et Spiritus Dei viventem et perfectum effecit hominem. *Hær.* v. 1. Hilary too, after laying down "Forma Dei *manebat*", *Trin.* ix. 14, adds, "ut *manens* Spiritus Christus, *idem* Christus homo esset", with a reference to the passage in St. Luke. Clement too says, contrasting the personality of the Christian λόγος with the Platonic, ὁ λόγος ἑαυτόν γεννᾷ. Strom. v. 3. This doctrine of one υἱότης with a double γέννησις, must not be confounded with the Sabellian tenet of the υἱοπατὼρ, which related to the Trinity, not the Incarnation. It is with the same purport that the creed in Epiphanius speaks of the Son as "not *in* man, but εἰς ἑαυτὸν σάρκα ἀναπλάσαντα, εἰς μίαν ἁγίαν ἑνότητα". *Ancor. fin.*

Thus Cyril, too, by the μία φύσις, means So much then on the light thrown upon the μία φύσις, viz., τοῦ θεοῦ λόγου, by the language of other Fathers. Cyril, too, does but teach that the φύσις of the Word is μία, one and the same. His "One nature of God" implies, with the Council of Antioch, a protest against that alterableness and imperfection, which the anti-Catholic schools affixed to their notion of the Word. The Council says "one and the same in *usia*": it is not speaking of an human *usia* in Christ, but of the divine. The case is the same in Cyril's formula; he speaks of a μία θεία φύσις in the Word. He has, in like manner, written a treatise entitled "Quod unus sit Christus"; and in one of his Paschal Epistles he enlarges on the text, "Jesus Christ yesterday and to-day the self-same, and for ever". His great theme in these works is, not the coalescing of the two natures into one, but the error of making two sons, one before and one upon the Incarnation, one divine, one human, or again of degrading the divine *usia* by making it subject to the humanity. *Vid.* also his Answers *adv. Oriental. et Theod. passim.*

the Word's eternity, Thus, for instance, he says to Nestorius: "It is at once ignorant and impious even to imagine that the Word of the Father should be called to a *second beginning of being*, or to have taken flesh of the Holy Virgin, as some kind of *root of his own existence*". *c. Nest.* i. p. 7. *Vid.* also *ibid.* p. 5, *c.*

So to Successus, "There is *one* Son, *one* Lord, before the incarnation and after; the Word was not one Son, and the child of the Virgin another; but *αὐτὸς ἐκεῖνος ὁ προαιώνιος*, man, not by *change of nature* but by economical good pleasure". *Ep.* 1, pp. 136–7. *Vid. c. Nest.* iv. *fin.* *Χριστὸν ἕνα καὶ υἱὸν καὶ κύριον ἀποτετέλεκε τὸν αὐτὸν ὄντα θεὸν καὶ ἄνθρωπον.* *ibid.* ii. 58. The *nature* of the Word *remained* what it was. *ibid.* i. p. 15. *Μεμένηκε ἐν ἀνθρωπότητι θεός.* *ibid.* iii. p. 73. "He is one, *καὶ οὐ δίχα σαρκός*, who *in his own nature* is *ἔξω σαρκός*. *ibid.* p. 45. *Εἷς νοεῖται μετὰ σαρκός.* *ibid.* 55. *Vid.* also ii. p. 60, a., and *ad Succ. Ep.* 2, p. 145. unity,

And, when he is formally called on to explain his formula, his language is still more explicit in the same sense. "He *remained* what he was, *φύσει θεός*; and he remained *one* Son; but *not without flesh*". *ad Succ. Ep.* 2, p. 142. "The *φύσις* of the Word has not *changed* into *τὴν τῆς σαρκὸς φύσιν*, nor the reverse; but, each *remaining* and being recognized *ἐν ἰδιότητι τῇ κατὰ φύσιν*, by an ineffable union, he shows to us *μίαν υἱοῦ φύσιν*, but that *φύσιν σεσαρκωμένην*". *ibid.* "Had we", he continues, "stopped without adding *σεσαρκωμένη*, they might have had some pretence for speaking, but *ἡ ἐν ἀνθρωπότητι τελειότης* and *ἡ καθ' ἡμᾶς οὐσία* is conveyed in the word *σεσαρκωμένη*". *ibid.* p. 144, etc. unalterableness.

§ 16.

(*b*.) Now we come in the next place to *σεσαρκωμένη*, and must return to the Council of Antioch and Paul of Samosata, and to Malchion, who was appointed by the Council to dispute with him. The same Council of Antioch enforces the doctrine that the Word's usia occupies the humanity,

Malchion views Paul's doctrine in its consequences to the humanity assumed. He accuses him of denying *οὐσιῶσθαι ἐν τῷ ὅλῳ σωτῆρι τὸν υἱὸν τὸν μονογενῆ*, Routh, *Rell.* t. 2. p. 476; *τὴν σοφίαν συγγεγενῆσθαι τῷ ἀνθρωπίνῳ οὐσιωδῶς*, p. 484; *δι' ἑαυτῆς ἐπιδεδημηκέναι οὐσιωδῶς ἐν τῷ σώματι*, p. 485; *οὐσίαν εἶναι οὐσιωμένην ἐν σώματι*, p. 485; *θεὸν συνουσιωμένον τῷ ἀνθρώπῳ*, p. 486;—that is, of denying that the divine *usia* in its fulness had simply taken possession of, occupied, and permeated an individual of our race, and that all that was in his human nature, totum quantumcumque, was lived in and assumed into the *usia* of the Word. What had been from eternity an *usia* only in itself, now manifested itself as *ἐν τῇ κτίσει* or *ἐν τοῖς γενητοῖς*; whereas Paul held nothing more than that a human *usia* had

received the Divine Wisdom *κατὰ ποιότητα*, p. 484. In a fragment of Africanus (A.D. 220) we find a statement parallel to Malchion's, the same prominence being given to the divine nature in contrast with the economy. *Ἐν τῇ οἰκονομίᾳ, ὡς κατὰ τὴν οὐσίαν ὅλην οὐσίωθεὶς, ἄνθρωπος λέγεται*, *ibid.* p. 125; that is, his absolute and whole divinity, not an emanation, or virtue, or attribute, simply filled, energetically appropriated, and sovereignly ruled a human nature as an adjunct; and he refers to *Col.*, ii. 9, in which it is said that in him, that is the human nature, dwells the whole fulness of the divinity, *σωματικῶς*, substantially. *Vid.* the striking passage in Cyril. *c. Nest.* i. p. 28, *a. b.* and *παχύνεται*, *Damasc. c. Jacob.* p. 409. In these statements the *usia* of the Word is put so prominently forward, as to imply *primâ facie* that in his economy there is no *usia* besides it. Compare with them Athanasius's words, in his *de Decretis*:—"As we, by receiving the Spirit, do not lose our proper *usia*, so the Lord, when made man for us, and bearing a body, was no less God: for he was not lessened by the envelopment of the body, but rather deified it and rendered it immortal".—14. If we brought out in a formal statement the impression which such a parallel creates, it is this:—that the Word had one *usia*, divine; and we one *usia*, human; and that, as our proper *usia* remains one and the same, *μία φυσις*, though it received grace, so the divine *usia* remained one and the same, though it took upon it humanity, as an adjunct or possession. And in like manner Didymus, on *Acts*, ii. 36, after contrasting the *usia* of the Word with the Word as "conformed to our *humiliation*", says, "To describe a thing as being *in this way or that*, is not to declare its *usia*". *Trin.* iii. 6.

and that the humanity is taken up into the Word's *usia*,

Now there is another way of expressing the same doctrine:—viz. to say, not that the Word came as an *usia* into a created nature, but became an *usia* to, or the *usia* of, a created nature. In this mode of statement it is not said that the Word *οὐσιώθη ἐν τῇ κτίσει*, but *ἡ κτίσις οὐσιώθη* in the Word; but the meaning is the same, for in both cases only one *Usia* is spoken of, who, besides being what he is in and for himself, *καθ' ἑαυτὸν*, *ἐφ' ἑαυτοῦ*, etc., also makes himself, and serves as, an *usia* to the created nature which he assumes. Thus (for illustration, but illustration only), fire *οὐσιώθη* in iron, or is *in* iron, because its real and substantial presence is in every part of the mass, which is simply mastered by it; and iron *οὐσιωθη* in fire, or is *in* fire, in the sense that it is transformed into

a new nature, which depends for what it is, solely on the presence of the fire. Accordingly Nazianzen, after saying θεοῦ δ' ὅλου μετέσχεν ἀνθρώπου φύσις, that is θεὸς οὐσιώθη ἐν φύσει ἀνθρώπου, goes on to speak of human nature as οὐσιωθεῖς' (*i.e.* ἐν θεῷ) ὥσπερ αὐγαῖς ἥλιος, *de Vit. suá*, v. 642, the material body of the sun being flooded with light. Here then, as little as in the former form of speech, are two *usias* spoken of.

This latter mode of speaking will be illustrated by the parallel use of it by Athanasius in relation to the creation generally, not to the hypostatic union. He says (analogously), that the whole universe depends for its stability upon the Word;—that the φύσις τῶν γενητῶν, as having its *hypostasis* ἐξ οὐκ ὄντων (*i.e.*, from what has no ὀυσία) is evanescent, and must be protected against itself. Accordingly, the Creator, οὐσιώσας τὴν κτίσιν in his Word, does not abandon it τῇ ἑαυτῆς φύσει φέρεσθαι, etc., *c. Gent.* 41. *vid.* Didym. *Trin.* iii. 4, p. 351. **as analogously the creation also is established in his *usia*.**

And this illustration enables us to advance a step further. Even in Nazianzen's verses, *usia* was contrasted with *physis;* the contrast is brought out more pointedly in the last statement of Athanasius, and it will appear that, if there were reasons for backwardness in calling the Word's humanity a substance or essence, lest it should introduce the notion of a second and independent being, so there were even stronger reasons against calling it a nature. **Contrast between *physis* and *usia*.**

Physis is a word of far wider extent of meaning than *usia*, and may be said to be the predicate of which *usia* is the subject. When applied to the Supreme Being, it means his attributes; as ἴδιον γνώρισμα τῆς θείας φύσεως ἡ φιλανθρωπία, Nyssen, *Orat. Catech.* 15. When applied to the universe, it means *phænomena;* hence, those who investigate them, as distinct from ontologists, whose subject is *usia*, are called physicists. When applied to man, it means his moral disposition, etc., as the Poet's "*Naturam* expellas furcâ", etc., and as we speak of good and ill nature. When applied to the moral (as the material) world, it means the *constitution* or *laws* which characterise it; Butler saying, that "the only distinct meaning of the word is *stated, fixed, settled*", *Anal.*, part i. ch. i. Hence, though (in the Catholic doctrine of Holy Eucharist) the *substance* of the bread ceases to be, the *natura*, as being what schoolmen have called the accidents, may be said to remain, as in the Epistle to Cæsarius ascribed to Chrysostom, in which we read, "divinâ sanctificante gratiâ, mediante Sacerdote, **The proper meaning of *physis***

dignus habitus est [panis] dominici corporis appellatione, etiamsi *natura* panis in ipso permansit".

shows the delicacy of applying the term to the humanity,

But if *physis* or *natura* is thus to be taken for the attributes and properties of humanity generally, as contrasted with *usia* or essence, it became a grave question whether, in applying it to the Word's humanity, there was not the risk of that very degradation of the divine *usia*, against which the Catholic writers, as we have seen, so strongly protested. If an human *usia* involved the risk of two beings or personalities, a human *physis* implied a contamination with human passions and excesses. St. Hilary, while he adopts the word, illustrates the abuse which might be made of it. "Assumpta caro", he says, "id est, totus homo, *passionum* esse permissa *naturis*". *Trin.* x. 24. Tertullian, on the other hand, taking the word in the same general sense, repudiates it, and adopts *substantia* (*usia*) instead, making *natura* equivalent to *culpa*. He says, that the Word, in taking flesh, abolished, "non carnem peccati sed peccatum carnis, non materiam sed *naturam*, non substantiam sed *culpam*". *de Carn. Christ.*, 16. Leo corrects this language pointedly, saying, "Assumpta est natura non culpa". *Serm.* 22, 3. Athanasius, too, as the Greek Fathers and Catholics generally, reserves the word *physis* for our moral constitution as it came from the Creator, and refers sin to the will of the individual. He says that it is "the impiety of the Manichees to say that the φύσις of the σὰρξ, and not merely the πρᾶξις, is sin". *c. Apoll.* i. 12–19; *vid.* also ii. 6–9, and *Vit. Ant.* 20.

which is in a state above nature,

But on the other hand, in matter of fact the humanity of the Word was *not* left in its natural state, but, as the Council of Antioch had said, τεθεοποίηται; since then it was beyond all doubt in a state *above* nature or *super*natural, why (as I have said above,) should it be any longer called a nature? It was that which *would have been* a nature, had it not been destined to be united from the first to the Word; but *in fact* it had been taken out of the massa, the φύραμα, τῶν γενητῶν, and been refashioned, as Isidore said, *supr.*, "by fire of the divinity". "The body itself", says Athanasius, "which had a mortal φύσιν, rose again ὑπὲρ φύσιν, on account of the Word which was in it, and lost the corruption which is κατὰ φύσιν, and became incorruptible, being invested in the Word, which is ὑπὲρ ἄνθρωπον". *Ad Epict.* 10. What had a special fulfilment after the resurrection, was analogously true in the incarnation itself.

When then Cyril said *σεσαρκωμένη*, he meant to express that our Lord's humanity had neither the ἡγημονικὸν of an *usia*, nor the imperfections and faults of a *physis*.

§ 17.

No wonder then, these things being considered, that, after we have done our utmost, we shall be unable to discover more than a few instances in the early Fathers, compared with the multitude of opportunities which the subject-matter of their works admits, of dogmatic statements verbally contrary to Cyril's formula, while, on the other hand, that formula admits, or even requires by its very wording, an explanation absolutely consistent with the Catholic dogma, as expressed, at least in Alexandria, up to his time. No wonder that, while the whole body of theologians admitted the ἐκ δύο φύσεων, it remained for a Pope, who saw with a Pope's instinctive sagacity the need of the times, to explain the old truth, in which all parts of Christendom agreed, under the comparatively new formula of the ἐν δύσι φύσεσι. To prove a negative, difficult at all times, cannot be expected here; but as I have given specimens of the Catholic use of *physis* or *natura*, in application to the humanity of the Word, which, though not near all which could be found, are sufficient to justify the Council of Chalcedon in adopting it into their formal definition of faith; so now, in conclusion, I will, in addition to the general considerations which I have enlarged on in explanation of Cyril's formula, set down some instances of the absence of the word *physis* in great theological authorities and others, in denoting the Word's humanity, where it might naturally have been expected.

and therefore not commonly called a *physis*, till Leo and Chalcedon, as proved from the fact that the early Fathers

§ 18.

(1.) Thus Athanasius, in a remarkable passage, in which his eagerness to avoid ascribing human imperfections to the Word's humanity makes him speak as if he would deny to it a will (which is contrary to his categorical statement elsewhere, *de Incarn. et c. Ar.* 21) uses *physis* simply for his divine nature. "He set up anew", he says, "the form of man in himself, in the spectacle of a flesh which had no fleshly wills or human thoughts, in an image of renovation. For the will is of the θεότης alone; since the whole φύσις of the Word was there". *c. Apoll.* ii. 10. And he argues, against the Arian objection from

appropriate the term to the divinity,

"The Lord created me", etc., in *Prov.*, viii. 22, not simply that it refers to the Word's human *usia*, but that it does *not* refer to his *usia* (as if he had no *usia* but one), that it refers to something happening περὶ ἐκεῖνον, something adventitious, an adjunct or circumstance, which does not at all warrant the inference that "what is said to be created is at once *in nature and usia* a creature". *Orat.* ii. 45.

describe the humanity as an envelopment

(2.) The force of this last expression περὶ ἐκεῖνον will be seen in the *de Decr.* 22, where he not only denies that the divine *usia* admits of accidents, but that it has anything "about it" necessary for its perfection; ἔξωθέν τινα περιβολὴν ἔχειν, καὶ καλύπτεσθαι, ἢ εἶναί τινα περὶ αὐτόν. Such a περιβολὴ then, or κάλυμμα, he considers the humanity. Hence, in spite of the Apollinarian perversion of the idea, we find it called a περιβολή. *Theod. Eran.* i. p. 23. κάλυμμα, Athan. *Sabell. Greg.* 4. προκάλυμμα Theod. *ibid. Adv. Gent.* vi. p. 877. καταπέτασμα. Athan. *ad Adelph.* 5. Cyril. *Cat.* xii. 26. xiii. 22. Cyril. Alex. *Quod unus.* p. 761. προπέτασμα. Athan. *Sabell. Greg.* 4 παραπέτασμα Theod. *ibid.* p. 22. στολή. *ibid.* p. 23. Velamen, Leon. *Epist.* 59, p. 979. *Serm.* 22, p. 70. 25. p. 84. *Vid.* also the striking illustration, Athan. *Orat.* ii. 7, 8.

as an adjunct,

(3.) A safer term, which became a term of science, was πρόσλημμα and the parts of its verb. ὁ πρὸς αὐτον ληφθείς, Athan. *Orat.* iv. 3. ὁ προσληφθεὶς ἄνθρωπος, Nyssen, *Antirrh.* 35. τὸ ληφθέν Cyril. *c. Nest.* iii. p. 69. κατὰ πρόσληψιν, Cyril. *ad Succ. Ep.* 2. p. 1422. πρόσλημμα Naz. *de Vit. suâ.* v. 648. Damasc. F. O. iii. 1.

and as an extract,

(4.) These words consider the humanity in relation to the divine *usia;* another word, "first fruits", which is taken from St. Paul, considers it in relation to that universal human *physis*, from which it was taken; but marks still the same reluctance in theologians to call it distinctly by the latter name. Ἀπαρχὴ ἐκ τῆς οὐσίας τῶν ἀνθρώπων, says Athanasius, *de Incarn. et c. Ar.* 8. And so *Orat.* iv. 33. Didym. *Trin.* iii. 9 fin. Cyril. *c. Nest.* i. p. 5. Nyssen *Antirrh.* 15 fin.

are silent about it as ὁμοούσιος or ὁμοφυής with us,

(5.) The same reluctance is evidenced by the omission of the phrase, ὁμοούσιος ἡμῖν, in relation to the humanity. This phrase is found in Eustathius and Theophilus *ap.* Theod. *Eran.* i. p. 56, ii. p. 154, and in Amphilochius *ap. Phot. cod.* 229, p. 789; as is ὁμόφυλος in Procl. *ad Arm.* pp. 613, 618. and ὁμογενής Athan. *S. D.* 10. But the word ὁμοούσιός itself Athanasius singularly avoids in this last passage, though he has just used it in expounding

John, xv. 1, etc. And he still more remarkably avoids it in his *ad Epict.* and *Contr. Apoll.* where it was the natural amendment upon ὁμοούσιος τῇ θεότητι, which he combats; yet he does not use it once, nay, he scarcely once, if ever, uses even ἐξ οὐσιάς Μαρίας, substituting for it simply ἐκ Μαρίας.

(6.) In like manner, in the antithesis between the divine and human natures, which is of constant occurrence in the Fathers, the word *physis* for the latter is scarcely found, but ἀνθρωπότης, σάρξ, οἰκονομία, etc. For instance, Athanasius says, "The Word was by *nature* Son of God, but by *economy* son of Adam". *de Inc. et c. Ar.* 8. "He was by *nature and usia* the Word of God, and *according to the flesh* man". *ad Epict. tit.* 12. Or, as Basil of Seleucia says, speaking of texts which refer to his mission, "These refer to his economy, *not* to his *usia*". *Orat.* 32, p. 171. and omit the obvious contrast of two natures.

I set down some instances of this contrast:—

1. θεὸς ἐν ἀνθρωπότητι. *Cyril. c. Nest.* iii. p. 84.
2. θεὸς ἐν σαρκὶ. Athan. *Orat.* ii. 71, *ad Epict.* 10.
3. θεὸς ἐν σώματι. *Orat.* ii. 12. *ad Epict.* 10. Nyssen *Antirrh.* 55.
4. δημιουργὸς ἐν σώματι. Athan. *ad Epict.* 10.
5. υἱος ἐν σώματι. *Orat.* i. 44.
6. λόγος ἐν σώματι. *Sent. D.* 8.
7. κύριος ἐν σώματι. *Orat.* i. 43.
8. λόγος ἐν σαρκί. *ibid.* iii. 54.
9. κύριος and his σάρξ. Nyssen. *Antirrh.* 44.
10. λόγος and his σάρξ. Athan. *Orat.* i. 47, iii. 38.
11. λόγος and his ἄνθρωπος. *ibid.* iv. 7.
12. λόγος and his ἐνανθρώπησις. Cyril. *c. Nest.* iv, p. 109.
13. λόγος and his ὀικονομία. Didym. *Trin.* iii. 21. Cyril. *c. Nest.* iii. p. 58.
14. υἱὸς and his ὀικονομία. Athan. *Orat.* ii. 76.
15. his οὐσία and his ὀικονομία. *ibid.* ii. 45, iii. 51.
16 his οὐσία and his διακονία. *ibid.* i. 12.
17. his οὐσία and his ἐπιδημία. Origen. *Caten. in Joan* i. p. 45.
18. his οὐσία and his ἐπιφανεία. Origen. *c. Cels.* viii. 12.
19. his οὐσία and his ταπεινότης. Didym. *Trin.* iii. 6.
20. his οὐσία and his δουλικὴ μορφή. Nyssen. *Antirrhet.* 25.
21. his οὐσία and his ἀνθρώπινον. Athan. *Orat.* iii. 51.
22. his οὐσία and his ἄνθρωπος. Origen. *c. Cels.* vii. 16.

23. his ὑπόστασις and his ἄνθρωπος. Athan. *Orat.* iv. 35.

24. his φύσις and his ἄνθρωπος. Origen. *in Joan. tom.* i. 30.

25. his φύσις and his ἀνθρωπότης. Cyril. *Schol.* 25.

26. his φύσις and his σῶμα. Athan. *Orat.* ii. p. 57.

27. his φύσις and his σαρξ. Athan. *Orat.* iii. 34. Cyril. *c. Nest.* v. p. 132.

28. his θεότης and his σάρξ. Didym. *Trin.* iii. 8.

29. his ἔνσαρκος ἐπιδημία. Athan. *Orat.* i. 59.

30. his ἔνσαρκος παρουσία. *ibid.* i. 8, 49, etc., etc. *Incarn.* 20. *Sent. D.* 9. *Ep. Æg.* 4. *Serap.* i. 3, 9. Cyril. *Cat.* iii. 11 *et alibi.* Epiph. *Hær.* 77, 67, etc., etc.

31. his σωματικὴ παρουσία. Athan. *Orat.* ii. 10.

The term ἄνθρωπος has not a fuller meaning than *physis*.

It may seem to some readers that the word ἄνθρωπος, which occurs among these instances, expresses the doctrine of a human nature even more strongly than φύσις could do, and even with some sort of countenance of the Nestorian doctrine of a double personality. But the word is in too frequent use with the Alexandrian and other divines to admit of the suspicion. I will set down one or two specimens of the parallel use of *homo* among the Latins. "Deus cum homine miscetur; hominem induit". Cyprian *Idol. Van.* "Assumptus à Dei Filio homo". Hilar. *in Ps.* 64. 6. "Assumptus homo in Filium Dei". Leon. *Serm.* 28, p. 101. "*Suus*", the Word's, "homo". *ibid.* 22, p. 70. "*Hic* homo". Leon. *Ep.* 31, p. 855. "*Ille* homo, quem Deus suscepit". Augustin. *Ep.* 24, 3.

Parallel of Hilary's phraseology.

The word "assumptus" in some of these passages is the Latin of the προσληφθεὶς spoken of above, and reminds us of Hilary's division of the Word's attributes into *naturalia* and *assumpta*, from which might be drawn an additional illustration, did we choose to pursue it, of the early theological language, and that the more striking, because, as we have seen, that Father has no difficulty of using the word *natura*, when the occasion calls for it, of the Word's humanity. *Vid.* the Benedictine Preface in *Hilar. Opera.*

§ 19.

Recapitulation.

To recapitulate the conclusions to which we have arrived, concerning the sense of the formula, μία φύσις σεσαρκωμένη.

Meaning of φύσις,

1. φύσις is the Divine Essence, substantial and personal, in the fulness of its attributes,—the One God.

And, τοῦ λόγου being added, it is that One God, considered in the Person of the Son.

2. It is called μία, (1) because, even after the Incarnation, it and no other nature, is, strictly speaking, ἴδια, *his own*, the flesh being "assumpta"; (2) because it, and no other, has been his from the first; and (3) because it has ever been one and the same, in nowise affected as to its perfection by the incarnation. μία,

3. It is called σεσαρκωμένη, in order to express the dependence, subordination, and restriction of his humanity, which (1) has neither ἡγημονικὸν nor personality, (2) has no distinct υἱότης, though it involved a new γέννησις, (3) is not possessed of the fulness of characteristics and operations which attaches to any other specimen of our race. On which account, while it is recognized as a perfect nature, it may be spoken of as existing after the manner of an attribute rather than of a substantive being, which it really is, as in a parallel way Catholics speak of its presence in the Eucharist, though corporeal, being after the manner of a spirit. σεσαρκωμένη.

§ 20.

It only remains to add concerning the formula, that, in spite of the misapprehensions to which it has given rise, and the suspicion with which it has been viewed, it is of recognized authority in the Catholic Church. Whether Athanasius himself received it, is a contested point. Flavian admitted it at the Latrocinium, A.D. 449, in the presence of its partizans, the Eutychians, who condemned and murdered him there. It was indirectly recognized at the fourth General Council at Chalcedon, A.D. 452, in the Council's reception of Flavian's confession which contained it. It was also received in the fifth General, and in the Lateran of A.D. 649. But, for this point of pure history, I refer the reader to Petavius *de Incarn.* iv. 6, who brings together all that has to be said upon it in the course of a few pages. Fortunes of the formula.

It is perhaps scarcely necessary to observe, that my reason for not referring in the above inquiry to the works of the Areopagite, to the disputation between Dionysius and Paul of Samosata, to Hippolytus *contr. Beron. et Helic.* and some other works and fragments, has been a disbelief of their genuineness.

ART. V.—"*The Sick-bed of Cuchulainn and the only Jealousy of Eimer*". [*Quoted from the 'Yellow Book of Slane' in Leabhar na h-Uidhre.*] *By* EUGENE CURRY, M.R.I.A.

[In printing the following article in the ATLANTIS, it is right to call the particular attention of the reader to the beautiful Irish type here for the first time employed—a type expressly cut for the Printing Office of the Catholic University, and the forms of which have been selected from the earliest original authorities. For the designs of these forms for the founder, the Editors are indebted to the kindness of one of the most accomplished of Irish artists, as well as our most learned of antiquaries, DR. GEORGE PETRIE, P.R.H.A. All the existing Irish type, with the exceptions presently to be mentioned, is not only for the most part very inferior in execution, but entirely inaccurate in design, many of the letters being quite unlike the genuine Irish models. The only exceptions have been in the instances of two forms of type cast within the last few years. The first of these was that designed some years ago by Dr. Petrie for the Ordnance Survey, a form which, with some improvements in the details of execution, has been carried out in the beautiful type used by Mr. Gill, at the Printing Office of Trinity College, in the printing of Dr. O'Donovan's Annals of the Four Masters (7 vols.), and in the publications of the Irish Archæological and Celtic Society, etc. The second is a new type, differing very little from the last named, and also cut from drawings by Dr. Petrie, which has been lately manufactured for Mr. Alexander Thom, the Government Printer. Both these types are perfectly accurate so far as regards authority for the forms used, which have been in every case taken without alteration from M.S. forms preserved in the earliest known M.S.S., some of them of a date so early as the sixth century, and in the inscriptions upon stone tombs, some of them of the ages immediately succeeding the introduction of Christianity into Ireland. These forms are much more rounded than those of the beautiful letters now for the first time employed, and the use of them in Irish writing is considered by some antiquaries prior in point of date. Other authorities, however, are of opinion that the more angular forms of the letters from which the present types are designed, are quite as ancient, if not even of still higher antiquity in Ireland; and there is no doubt that at all events the angular letters are those in which the Irish language was written in the early as well as always in later centuries, and that it is this form of letter which is so peculiar to Irish scribes that it is known everywhere as immediately characteristic of the nationality of the M.S. in which it is employed. It would seem indeed that both styles of letter were used by the earliest known Irish scribes. The rounded form seems to have been almost always used in the transcription of Latin pieces, and for writing in what we should now call capital letters. On the other hand the angular form seems to have been always preferred, if not invariably used, in transcribing pieces, and even mere occasional sentences, in the Irish language. So the Book of Kells (a copy of the Gospels), which is altogether in Latin, is altogether written in rounded capital letters; and it is chiefly upon the authority of this M.S. (believed to be of the sixth century) that the advocates of this form support themselves. And in the Book of Hymns (a M.S. of the ninth, or early part of the tenth century), the *text*, when it is Latin, is beautifully written in the same style. So in the celebrated M.S. copy of the Psalms, called the "*Cathach*", in the handwriting of Saint Columcille, written in the sixth century, the forms are altogether rounded, or rather indeed absolutely Latin forms, that book being altogether in the Latin language. And in the fragments of the earliest M.S. of all, the Gospel called that of Saint Patrick, because the M.S. was in his possession if not actually in his handwriting, (fifth century), the letters are almost all rounded as in the Book of Kells, the language being also Latin. On the other hand, the Book of Armagh, a collection transcribed at the close of the eighth century, is altogether written in the angular style, although almost all the contents of that book are in the Latin language. And in the Liber Hymnorum, above referred to, (of which one part has lately been beautifully printed by the Irish Archæological and Celtic Society, edited by the Rev. J. H. Todd, F.T.C.D., P.R.I.A.), all the *prefaces*, *notes*, and *glosses*, forming by far the greatest part of the M.S., are invariably written in the angular form of character, being in the Irish language; as are also those portions of the text in the same language, such as *Fiach's Hymn*, etc. All the Irish M.S.S. later than the tenth century are invariably in this latter style, the custom of writing even Latin in the more rounded form having by that time disappeared. So that the form of the type now for the first time used, is not only that of the Book of Armagh, and of the Irish writing in the Liber Hymnorum, but is also that of the *Leabhar na h-Uidhre* itself (circa 1100); of the *Saltar na Rann*, in the library of Oxford (same date); of the Book of Leinster (1100—1160); of the *Leabhar Breac*, or Speckled Book, in the R.I.A. (1380—1400); and of all the M.S.S., it may be added, cited by Zeuss in his work; as well as of all the later vellum M.S.S. such as the Books of Ballymote, of Lecan, etc. To conclude, the forms adopted in the present type have been carefully drawn by Dr. Petrie from those of the Book of Hymns, in which will

be found the exact fac similes of every form among them; and this was done after a critical examination by Dr. Petrie and Mr. Curry, not only of the various forms used in the Liber Hymnorum (which is one of the most beautifully written M.S.S. in existence), but of those occurring in all the other early vellum M.S.S. in Dublin more particularly remarkable for careful calligraphy; and particularly in the *Leabhar Breac*, in the library of the R.I.A.,—the Astronomical Tract in the same collection (18.5), written circa 1400,—a beautiful fragment of the Laws, older than but bound up at the end of a copy of the *Felire Aengus*, which is dated 1463 (43.6. R.I.A.),—another exquisite M.S. in the R.I.A., containing portions of the Laws, written about the beginning of the sixteenth century (35.5.),—another similar M.S., (there classed 46.6),—and in an ecclesiastical fragment, consisting of a few leaves, of the earlier date of the tenth century, bound in a volume of the Laws, in the Trinity College Library, classed H. 3.18. These are then the authorities for every letter of the present type, which may perhaps be regarded as the most perfect, if not the first perfectly correct, Irish type ever cut.]

The original MS. of this tale (circa A.D. 1100),

THE following tale, now translated and published for the first time, is copied from an ancient vellum manuscript, preserved among the rich antiquarian treasures of the Royal Irish Academy. This volume was originally of small folio size, and contained a now unknown number of leaves, or folios, of which sixty-nine only remain at present. From a memorandum in a space left originally blank, written in about the year 1345, at Sligo, by Sígraid O Cuirnín, (Sigraidh O'Cuirnin), it appears that this book was compiled, from various other more ancient books, by Maelmuire, the son of Ceilechair, who was the son of Conn na m-boċt (Conn-na-mbocht), or Conn of the Poor, a distinguished nobleman of Ulster, who, abandoning the world, retired to the sacred cloisters of Clonmacnois, and spent the close of his life in acts of devotion and charitable attendance on the poor, and who died in the year 1031. The sons and grandsons of this Conn appear, from various ancient authorities, to have held a high literary position at Clonmacnois; but the wreck of time, and the adverse political state of this country for the last seven hundred years, have been fatal to the preservation of their works, as well as to those of a host of other distinguished men of the ancient times; and no vestige of their labours is now known to exist but the present fragment.

written by Maelmuire, grandson of *Conn-na-mbocht.*

Extent of the M.S.

The fragment consists of 67 leaves of vellum; these leaves are numbered to 84, in writing now probably 200 years old; the folios between one and seven are, however, lost, and there are several other chasms besides.

Books quoted in it.

The following old books are quoted in it: The Book of Nennius (fol. 7 b.); The Yellow Book of Slane (fol. 36 a. 38 a.); The Short Book of Monasterboice (fol. 36 a.); The Books of Eochaidh O'Flannagan (fol. 36 a.); The Books of Monasterboice (fol. 36 a); and the lost Book of Dromsnechta (fol. 67 a. 80 b.).

The principal contents of the M.S.

The most important of the contents of the book (besides a great number of valuable fragments of tales and poems,) are:—

Dallan Forgaill's poem,

The celebrated Poem by Dallan Forgaill on S. Colum Cille (fol. 8), of which some folios are lost. This poem has always been considered by Irish scholars, ancient and modern, the most difficult piece of composition in the language. This is the oldest copy of it known, though it is not so complete nor so copiously glossed as that in the "Yellow Book of Lecain", a M.S. of the fourteenth century, in the library of Trin.Coll., Dublin (classed H. 2, 16). The gloss contains quotations from several ancient Irish poets.

Book of Invasions,

Part of the Book of Invasions, containing an account of the first colonies in Erinn, as delivered by Fintan to S. Finen of Movilla, in the sixth century (fol. 14 a.a.).

Several historic tales,

Portions of the celebrated old tales called The Inebriety of the Ultonians, The Cattle Spoil of Dartadh, The Cattle Spoil of Flidais, and The Wanderings of the Boat of Maelduin (fol. 23 to fol. 25 b.a.). Of these tales more perfect copies are also preserved in the Trin. Coll. M.S. just referred to.

Religious pieces,

The Vision of S. Adamnan; followed by Ancient Sermons on the Day of Judgment and the Resurrection (fol. 30 to 33 b.).

Historical tracts,

The Death of King Dathi, and the burial places of the Kings of Erinn, (fol. 35 b.); The Story of Liban, (fol. 36 a.); The Causes of the Battle of Cnucha, in the Second century, in which fell Cumhall, the father of the celebrated Finn, (fol. 37. b.).

The Story of the Sick-bed of Cuchulainn, now printed.

On the causes of the banishment of the Desies from Tara into Munster, in the reign of Cormac Mac Art, A.D. 270, (fol. 43 a.a.).

The *Táin bo Chuailgne*,

A fine copy of the Táin bó Chuailgne, (fol. 45), defective five folios.

and several other historical and legendary pieces.

And lastly may be mentioned, imperfect copies of The Destruction of the Court of Bruighean da Derga; of Bricrend's Feast; of the wild religious tale called The Ghost of Cuchulainn's Chariot; of the Account of the Battle of Carn Conaill (seventh century); of the Conversion of King Laoghaire by S. Patrick, and of the Miracles of the Saint; The Prophecy (or Vision) and Christian Belief of Art the Solitary (the father of King Cormac), who was killed at Magh Mucroimhe, A.D. 180; The Adventures of Connla the Beautiful (son of Conn of the Hundred

Battles, and only brother of King Art); the Story of The Courtship of Emer (by Cuchulainn); the ancient Story of the Conception of Cuchulainn, from the Book of Dromsnechta; part of the ancient Tale of the Education of Cuchulainn, etc.

Of Maelmuire, and his death, in A.D. 1106.

Of Maelmuire (a name which literally signifies Tonsured to the Blessed Virgin Mary), grandson of Conn of the Poor by his son Ceilechair, the compiler and scribe of this once beautiful book, we know nothing more than what has been already said, and the melancholy fact of his having been slain in the great Church of Clonmacnois, by a party of robbers, in the year 1106.

This M.S. compiled from the original Leabhar na h-Uidhre of Saint Ciaran,

The present book was known by the name of Leaḃar na h-Uiḋre (Leabhar na h-Uidhre, or the Book of the Dun Cow), so called after another ancient book belonging to Clonmacnois, containing the history of the Táin bó Chuailgne (Tain Bo Chuailgné), and probably other historical tales, which had been written by Saint Ciaran, the founder of Clonmacnois, on the preserved and prepared skin of a favourite Dun Cow, which had followed him from his father's flock when he eloped from him to a monastery in his boyhood, and which he kept afterwards with great veneration till her death of old age.

and from the "Yellow Book of Slane".

But it is evident that Maelmuire did not compile his book exclusively from the original Leabhar na h-Uidhre, as he gives the names of several other ancient books from which he is transcribing, and among them the Leaḃar buiḋi Sláne (the Yellow Book of Slane), of which we have no further account, and from which the present piece was copied by him, thus throwing its original composition back to at least the time of compiling this Yellow Book of Slane—a period, as I believe, of perhaps five or six hundred years from the time of Maelmuire himself.

History of the present M.S.

At what time, or under what circumstances, the present Book of the Dun Cow passed from its original home at Clonmacnois, we are now unable to say; but from the memorandum already mentioned, we find that about the year 1340, it was given by Conor O'Donnell, Prince of Tirconnell, to Cathal O'Conor, Lord of Sligo, in ransom for the son of O'Donnell's hereditary family historian, who had been taken prisoner by O'Conor. The book appears to have remained in Connacht from this time to the year 1470, when Hugh Roe (the Redhaired) O'Donnell, Prince of Tirconnell, led a large force into that country, and laid siege to the Castle of Sligo, which after a con-

siderable time he took from the O'Conor. The chief object of this siege appears to have been the recovery of this book, and another ancient book called the Leaбap Ʒeapp, (Leabhar Gearr, or Short Book), which had been given by the O'Donnells in ransom for John O'Doherty, who had been previously captured by the O'Conors; with all of which the valiant Hugh Roe returned in triumph to Tirconnell.

Love of the Gaels for their national history and literature.

The history of this remarkable volume (and that indeed of many others which, if space permitted, we could name), affords a striking evidence of the love which the ancient Gaels have ever entertained for the historical and literary monuments of their native country.

Contents of the original "Book of the Dun Cow".

The Book of the Dun Cow, in its original complete form, appears to have been a great repository of the oldest mythological tales in the Gaelic language; but, unfortunately, a few only of them remain in a perfect state in the present fragment of it. Of these few the following, as well in point of the antiquity of the style and orthography of the language, as for preserving to us a good type of the mythological notions of the ancient Gael, is perhaps as good a specimen as could be selected for the pages of this periodical.

The style of the language in this M.S.

The style of this tale will not, however, come up to the standard of antiquarian purity which the philological school of the present day has erected for itself. The language is not as severely systematic in some of its grammatical forms as the writings of some of the ecclesiastical scribes of the middle ages, whose glosses upon the Latin, in their own handwriting, are now preserved in some of the ancient monastic libraries on the Continent, and from which large, but sometimes inaccurately copied, quotations are given by the learned and lamented Zeuss in his great work, the *Grammatica Celtica*.

Grammatical forms of the early ecclesiastical scribes.

These continental glosses are, I believe, generally referred to the eighth, ninth, and tenth centuries, and it is quite clear that the ecclesiastical, and doubtless the other writers, of that and an earlier period, employed a language the grammatical forms of which were far more regular, and far more in consonance with those of the other Indo-European tongues, than those which were used by the writers of the Leabhar na h-Uidhre, and the Leabhar Breac, and perhaps even than those found in the Liber Hymnorum.

Examples of grammatical forms

One of the chief evidences of the antiquity of Gaelic composition insisted on by modern philologists is, I believe, the presence of the article in a plural form of termination, in order to agree with nouns in plural forms, in the

ablative and dative cases, as in these instances: "Adciam isnaib inscib scoelius indecni"—"We see in the words which the church (or, the wise man) puts forth". And again: "Issí in derc martre dó, foididu cruche ocus diorcne ar Crist, amail, dno, do choemnuchuir dundaib apstolaib oc ingrimmim ina cloen ocus oc forcetul rechto dée; congaibetur ina tré chenele martre so issnib colnidib"—"The red martyrdom to him is to suffer crucifixion and slaying for Christ's sake; such, now, as the apostles attained to while extirpating vices and promulgating the law of God: so that they received these three kinds of martyrdom in their bodies" (or, in the flesh).

supposed by modern philologists to demonstrate the antiquity of a Gaelic M.S.

(These words are taken from an ancient homily preserved at Cambray, in a manuscript which can scarcely be of later date than between the years 763 and 790, when Albericus was bishop of Cambray and Arras.)

The Cambray M.S.

Another indication of ancient construction with the philologists is, I believe, a plural termination of the adjective to agree also with the termination of nouns in the plural number. (And here, by way of parenthesis, I should wish to ask those learned investigators who have access to the ancient Gaelic M.S.S. on the Continent, if they have found those forms strictly adhered to in any ancient *poems* which these M.S.S. may happen to contain; because I much doubt that the requirements of melody would tolerate these frequent consonant terminations.)

Another indication of ancient construction according to the same authorities.

These dogmas, however, if such they be, do not appear, to me at least, to be perfectly safe guides in determining the age of any piece of Gaelic composition; and for this simple reason, that we have very ancient Gaelic compositions in which they are not invariably present, while we have others several hundred years later in which they are conspicuous enough. And, without burdening these few observations with any elaborate illustrations of this fact, we may at once refer the inquirer to the Book of the Dun Cow, the Book of Leinster, the Leabar Breac, (Leabhar Breac, or Speckled Book), the Book of Ballymote, and the Book of Lecan, all compiled between the close of the eleventh and the beginning of the fifteenth centuries—say between the years 1100 and 1416. In all these books, and in others that could be named, in profane as well as in sacred writings, numberless instances of the above grammatical forms may be found; but it must be admitted that they are not strictly adhered to, as they are in the writings of those men who appear to have always aimed at classical regularity and uniformity.

Doubts whether the rules of the philologists referred to are safe guides in the investigation of Gaelic M.S.S.

The present piece selected as a specimen of the early language specially interesting to philologists.

It must not, however, be supposed for an instant, from the observations just made, that I am not a hearty advocate and admirer of the labours of the modern comparative philologists—to whom, indeed, my approval or disapproval would be of little moment. With some of them I have the honour of an intimate acquaintance, and with others the happiness of a highly prized friendship, warm and of long standing. And I am anxious that it should be known that my chief reason for selecting the present tale for publication is in order to place before these deep thinking and painstaking philological investigators a specimen of composition older, at least in point of transcription, than any other sustained piece of profane writing in the language hitherto published.

Antiquity of the language in this piece.

If the language in this tale is not pure, according to the native cultivation at least, we need never expect, I fear, to meet with purer. It is certainly as old and as pure as the language found in Cormac's Glossary, which was compiled about the last quarter of the ninth century, and of which we have a fragment in the Book of Leinster (a compilation of the middle of the twelfth century), and copied, there is good reason to believe, from Cormac's own handwriting, or book, the Psalter of Cashel.

The subject of the piece.

And now to return to the subject of our tale. We have only to premise that Cuchulainn, the hero of it, was a native prince of Ulster, and the inheritor of the districts of Cuaılᵹne (Cuailgne) and Muıꞃṫemne (Muirthemne), lying between and including the present towns of Drogheda and Dundalk, and now called the county of Louth.

Of Cuchulainn.

Cuchulainn's chief residence was Ꝺun Ꝺelᵹa (Dundalk), and he was the most distinguished of the band of Ulster heroes who, in our ancient writings, are called Cuꞃaıḋe na Cꞃaıḃe Ꞃuaıḋe (Curaidhe na Craibhe Ruaidhe), that is, the Champions or Knights of the Royal Branch.

The "Royal Branch".

This "Royal Branch" was one of the celebrated palaces of the ancient city of Emania, the chief city and royal residence of the kings of Ulster from a remote ante-Christian period down to the year of our Lord 331, when it was destroyed by the Three Colla's (of the Heremonian race), who wrested the province and its sovereignty from the Rudricians, its proprietors from the Milesian conquest to this time.

Conor Mac Nessa.

Conor [Concoḃaꞃ] Mac Nessa (so called from his mother Nessa), was the most distinguished king that ever ruled at Emania. He was cotemporary with our Saviour; and it was in his time that the fame of the Knights of the Royal

Branch arose to the highest degree of honour. Among the most conspicuous of these knights were Fergus Mac Róigh, Conall Cearnach, Fergus Mac Leité, Curoi Mac Dairé, and Cuchulainn Mac Soalte, who was the youngest of them all.

Knights of the Royal Branch.

Of the Lady Eimer.

The Lady Eimer, whose name appears in the tale, was the beautiful daughter of Forgall Monach, a chief who held large possessions along the coast of the present counties of Meath and Dublin, and whose princely residence was at the place now well known as Lusk, in the county of Dublin, but which in the olden times was from him called Dún Forgaill Mónaċ (Dun Forgaill Monach). The wooing and winning of the Lady Eimer, by Cuchulainn, against the consent of her father, forms in itself another celebrated ancient tale, a very curious and very wild tract, of which I have in my possession an excellent copy.

Of Labraid "of the quick hand".

To Labraid "of the quick hand at sword", and to his enchanted island, I have never met with any other reference but what this tale contains, except in one other tale in which he acts a part, preserved in a valuable M.S., known as the Book of Fermoy, purchased at a late sale in London, by the Rev. Dr. Todd, F.T.C.D., and destined for the noble Library of the Royal Irish Academy. He must of course have been one of the mysterious Tuaṫa De Danann (Tuatha De Danann); and from certain allusions in the text, as well as from two insertions in the Annals of the Four Masters, his island appears to have been an inland one, and situated somewhere in or about the confines of the present county of Fermanagh.

[The text of the following tale is printed exactly as it is found in the original vellum M.S., save only that the contractions are omitted and every word given in full. The different words are even separated or united precisely as in the original. The division into paragraphs is, however, that of the present editor, made for convenience of reference, the paragraphs in the original and translation being arranged to correspond.

The accompanying lithograph is an exact fac simile of the commencement of the tale, as it is written in the original. The page is a large quarto or small folio in shape, the vellum leaf, in its present state, being about 26.5 centimetres (about $10\frac{3}{10}$ inches) long, by about 20.5 centimetres (about 8 inches) broad, including the margins. The M.S. is written in columns, not in lines across the whole page. The lithograph contains as much of the first of the two columns of the first page as could conveniently be printed in the present publication. The original extends to eight lines more to the column. The fac simile will show, better than any description, the nature of the contractions and the form of the letters used in a good Irish M.S. of the end of the 11th or beginning of the 12th century, written, however, not with the studied beauty of style which characterizes our best Gaelic M.S.S., and will be particularly interesting, no doubt, to those who have not access to the M.S. collections of Dublin, London, or Oxford.]

[SLICHT LIBAIR DUIB SLANI.]

SEIRGLIGI CONCULAINN INSO SIS, OCUS OENET EMIRE.

Oenaċ dogníṫe laUlta ceċabliadna .i. trílá ríasamfuin ocus trílá iarma, ocus laṫe na samna feisne. ISseḋ eret nobitís Ulaid insin immaig Muirṫemni, oc ferṫain oénaig nasamna ceċabliadna. Ocus nirabe isin biṫ ní dogneṫe innerersin leú act cluċi, ocuscéti, ocusániuṡ, ocusaibinnius, ocus longad, ocus tomailt, conid desin atát natrénae samna feċnón nahErend.

Feċtas and tra, ferta oénaċ la hUltu immaig Muirṫemni ocus bahairi noferta leu, fobiṫ tabarta doċaċ aċompraime ocusagarcid dogrér ceċasamna. Dabér leu dna, diag innacompraime ferṫain indoénaig. [Ba si in compraime imorro][1] .i. rind aurlabra ceċfir nomarbtís do ṫabairt innamborrán, ocusdobertis aurlabrai nacetrae doilúgud nacompram hisudiu, ocus doberead cáċ aċompram andsin ósairid, act bá cáċ arúair, ocusisamlaid dognítis sin ocusaclaidib forasliastaib intan dognítís in compram. Arimrótis aclaidib friu, intan dognítis gúċompram. Deiṫbir ón arnolabraitis demnassiu dianarmaib, conidde baticcomarċi fursro anairm.

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[1] These words appear to have been left out of the text by mistake.

[2] Samfuin (*Samfhuin*, or Samhuin). This is a compound word, composed of Sam (*Sam*), an ancient Gaelic form of the present word Saṁraḋ (*Samhradh*), Summer, and fuin (*fuin*), an ancient Gaelic word for "end"; so that samfuin means merely the "end of Summer"; and the name was properly applied to the last night of October, which was, and still continues to be called Oiḋċe Saṁna, *shamhna* being the condensed genitive from saṁfuin (*samhfhuin*), in accordance with a well-known rule of Gaelic grammar. The authority for this derivation is to be found in the following short explanation, preserved in an ancient M.S. in the Library of Trinity College, Dublin, class H. 3, 18:—Samfuin .i. fuin in tsamraid ann; ar is de roinn no bit forran mbliadain anall .i. in samrad o Beltaine co Samain; in geimrid o Shamain co Beltaine. "Samfhuin", that is, the end of the Summer at it; because it was two divisions that were on the year of old, that is, the Samrad (Summer), from Beltaine (May) to Samain (November); and the geimrid (Winter), from Samain (November) to Beltaine (May). Although this division of the year into two simple parts may have been and doubtless was current in Erinn in the very remote times, it is very clear that they had a division into four quarters at a very early time too, because they have had in ancient times and have still original native words to denote them They also had a custom of celebrating, in a simple way, the opening of every new quarter of the year, by certain feasts and practices, not only of a public but of a domestic or social character; a fact commemorated in an ancient poem of four stanzas for the four quarters, in my possession, from which it appears that their year commenced with the present month of February, as the seasons always do. The following is the stanza of this poem which tells us how the Samhain was ushered in:—

["*From the Yellow Book of Slane*".]

The Sick-bed of Cuchulainn, and the only jealousy of Emer.

The Ultonians had a custom of holding a fair every year, which lasted the three days before Samhain[2] [the first of November], the day of Samhain itself, and the three days that followed it. That was the period of time which the Ultonians devoted to the holding of the Fair of Samhain in the Plain of Muirtheimne[3] every year; and nothing whatever was done by them during that time but games and races, pleasure and amusement, and eating and feasting; and it is from this circumstance that the Tertiæ (three days) of Samhain are still observed throughout Erinn.

On one occasion a fair was held by the Ultonians in the Plain of Muirtheimne, and the reason [or origin] of holding the fair was, because every one exhibited his trophies of war and valour always at Samhain. It was a custom with them, now, after the trophies, to hold the fair. [The trophies were,] *i. e.*, the top of the tongue of every man they slew to bring it with them in their pouches; and they used to bring the tongues of cattle to multiply the trophies; and every man then exhibited his trophies, but it was each in his turn; and the manner in which they did this was, to have their swords lying across their thighs when showing the trophy, because their swords would turn against themselves if they held forth a false trophy. The reason of this was, because demons were accustomed to speak to them from their arms; and it was hence that their arms were inviolable.[4]

Carna, coirmib, cnomes cadla,
Até ada na Samna;
Tendal ar cnuc, co ngrinne,
Blátac, breċtán úr imme.

Fleshmeat, ale-cups, beautiful nuts,
These are the privileges of the Samhaim:
Fires upon hills, with assemblies,
Buttermilk, rolls of fresh butter.

[3] *Muirtheimne.*—This was the name of an ancient territory, which was situated in the present county of Louth.

[4] *And it was hence that their arms were inviolable.*—That is to say: If a king or knight swore by his sword, or by his arms, that oath was inviolable; and if the sword, spear, or the arms of a king, chief, knight, or chief poet, were given or pledged as a protection to a person, it was disgraceful and unlawful to abuse that protection. See the Second Battle of Magh Tuiredh; and the Story of Cormac Gaileng in Cormac's Glossary.

Tancatar Ulaid uli doċom indoenaig, act diar namma .i. Conall Cernaċ ocus Fergus mac roig.

Fertair anoénaċ, olUlaid. Ni firfider, olCuculainn, coti Conall ocus Fergus; fobiṫ bahaiti dó Fergus, ocus bacomalta Conall Cernaċ.

Arbert Senċa iarom: Imbertar ficella dún coléic, ocus canitar drećtu, ocus agat clesamnaig. Dognítear iarom anísin.

Ambátar and iarom, tairnid enlaiṫ forsinloċ ocaib; níbatar in Ere énlaiṫ bacaíni.

Batar imtoltanaig namná imnaheónu imdarubart fair. Gabais cáċ díb immarbaig ammuin aceli imgabáil nanén.

Arbert Eṫne Aitencaiṫreċ,[5] ben Conċobair: arásursim én ceċtar modágúalann dindénlaiṫ ucut. Assagussem uli, ol namná, anísin. Mágabtair doneoċ is damsa cetugebṫair, ol Eṫne Ingúba, ben Conċulainn.

Cid dogénam olnamná. Nin.[6] forlebortċam ingen Oa ocus Adairce, rigasa úaib do ċuinċid Conculainn.

Luid iarom, co Coinculainn ocus arbert fris: Isáil donamnáib indeóin ucut uatriu. Ateta aclaideb doimbert fuirri. Ni fogbat merdreċa Ulad anaill act forsaim én dóib doṫabairt forind indiu. Nicóir duit em, forlebortċam, fúasnad friu ásis triut atá intres anim fil formnáib Ulad .i. guille, ar ité teóra anmi fil formnáib Ulad .i. cluine, ocusminde, ocusguille. Ar ceċben roċararstar Conall Cernaċ, ba cloén, caċ ben dona, roċarastar Cuscraid mend mac Conċobair dobered forminde foraerlabrai; atá samlaid, ceċ ben rocarastar Conculainn nogollad iarom arosc foċosmailius Conculainn, ocus arareirc, arba dán dósom, intan banolc amenma, noslocad indalasúil connaroċed corr innaċind. Doteirged indalanai immaċ commeit ċori ċolbṫaigi.

Indel dún in carpat[7] a Laiċ, olCuculainn. Indlis Loég iarom, incarpat ocus téit Cuculainn sincarpat, ocus atais taiṫbéim diaclaidiub dóib coruiloetar ambossa ocusaneti dindusciu.

Nosgaibet uli iarom, ocus dosbertatar leó, ocussfodailset donamnáib connarabi ben nadrissed dá én dib act Eṫne

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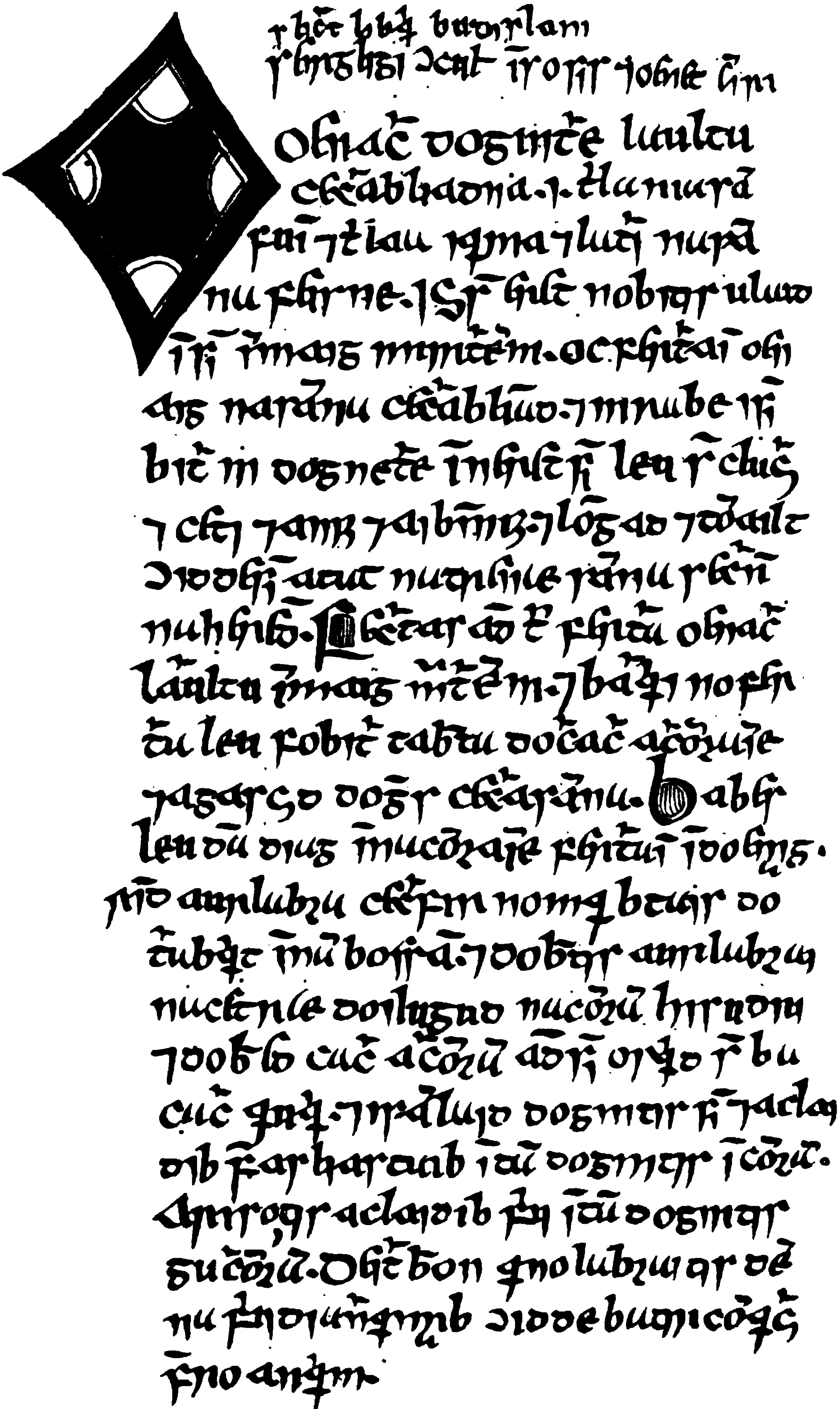
[5] *Etanchaithrech*, *i.e.* of the hairy face.

[6] In all our ancient manuscripts this contraction is put for the words, "ni handsa a indisin", *i.e.* "it is not difficult to tell that"; but it has been more convenient to preserve the contraction in the form of nin., and translate it "answer".

[7] *Chariot* (carbat). Of the remote antiquity of chariots in Erinn there cannot be the least doubt; and our ancient annals enable us even to assign a date to the first introduction or invention of the chariot in this country. There is an ancient tract on the etymologies of the proper names, or rather surnames, of the most remarkable men and women to be met with



(Erratum to Text.—The Original extends to 13 lines more to the column.)

Facsimile of part of Leabhar na h-Uidhre in the collection of the Royal Irish Academy.

All the Ultonians came to the fair on this occasion, except two alone, namely Conall Cearnach and Fergus Mac Roigh.

Let the fair be commenced, said the Ultonians. It shall not be commenced, said Cuchulainn, until Conall and Fergus have arrived, (for Fergus was his [military] tutor, and Conall was his fellow-student).

Sencha [the poet] said then: Let us play chess for the present, and let poems be sung for us, and let games be arranged. This was then done.

Whilst they were thus engaged, a flock of birds alighted on the lake in their presence, and in Erinn there were not birds more beautiful.

The women present were desirous to have the birds which moved on it [the lake]. They all began to contend with one another about the possession of the birds.

Eithne Aitenchaithrech, King Concobar's [Conor's] wife, said: "I must have a bird of these birds on each of my two shoulders". "We must all have the same", said the other women. "If any one is to get them, it is I that must first get them", said Eithne Inghuba, Cuchulainn's mistress.

"What shall we do?" said the women. "I shall tell you", said Lebharcaim, the daughter of Oa and Adarc, "I will go from you to Cuchulainn to ask him".

She went then to Cuchulainn, and said: "The women desire to get these birds from you". He threatened to strike her with his sword, and said: "The courtezans of Ulster will have nothing less than to send us a bird-catching to-day!" "It is not proper for you, indeed", said Lebharcaim, "to be angry with them, because it is through you the women of Ulster have one of their three blemishes, namely, to be half blind". For, the three blemishes of the women of Ulster were, stooping, stammering, and half-blindness. For every woman who loved Conall Cearnach became bent; every woman who loved Cuscraidh Menn, the son of Concobar, got an impediment in her speech; in the same way every woman who loved Cuchulainn became blind of an eye, like Cuchulainn, and from the intensity of her love for him; because it was his practice, when he was out of humour, to draw one of his eyes back, so that a crane could not reach it in his head; the other he would press out so that it would be as large as a heifer's cauldron.

"Yoke for us the chariot, Laegh", said Cuchulainn. Laegh yoked the chariot,[7] and Cuchulainn went into the chariot, and

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in our ancient manuscripts, but confined, chiefly, to the Milesian line, preserved among our old records, and known as the Coir Anmann, or Explanation

Ingúbai a hoénur. Tánic de iarom, coamnai féssin. Is olc do memna, ol Cuculainn fria. Niholc oleṫne, uair is uaim fodailter doib. Isdeṫber dait, olsi, nisil diib mnai naċit-ċarad noná beṫ cuit dait; uair mad meisi, nisil cuit donáċ ailiu immumsa aċtouitsiu ṫoénur.

Nábad olc do menma tra, ol Cuculainn, diatísad eóin mag Murṫemni, nó Boind, indaén baháildem dib duticfad.

Ni boċian iarom conaccatar daén forsindloċ ocussond

of Names. In this tract (part of which is preserved in the Book of Leinster), it is stated that Chariots (carbait) were first invented in Erinn by Righairled, a prince of Munster, the fourteenth in descent from that Eiber Finn (the son of Milesius, one of the three surviving brothers and leaders of the Milesian colony), who was ancestor of all the Eberian families of Munster; and the time of the invention, according to the chronology of the "Annals of the Four Masters", would be about anno mundi 4000. That the chariot invented by Righairled was one of two wheels (perhaps, indeed, without wheels at all), and for two horses, may be inferred from the fact that Rotheachtaigh, a monarch of Erinn, of the Eremonian line, is said to have received the name of Rotheachtaigh (that is, possessor of wheels), from his having been the first to yoke four horses to a chariot in Erinn. He was killed by lightning at Dun Sobhairce (modernised "Dun Severick)", in the present county of Antrim, anno mundi 4170. It will be seen that both these references apply to the Milesians, to the exclusion of their predecessors, the Firbolgs and Tuatha de Danann. All our ancient tales abound with references to chariots, and those not only for the ordinary purposes of carriages, but also in some few instances, for battle. Thus we find, in the Táin bó Cuailgne, of which we have copies as old as the year 1106, that when Meave, Queen of Connacht, was setting out on that famous expedition, she had nine chariots appropriated to herself alone: two chariots before her; and two chariots after her; and two chariots at each side of her: and her own chariot in the middle of them. The reason (says the tract) that Meave went forth in this order was, in order that the sods thrown up by the hoofs of the horses, and the foam of their bridle bits, and the dust of the great army, should not tarnish the queen's golden diadem. It appears that the war chariot was furnished, if not with cushions, at least with cloths and skins, on which the warrior and his charioteer sat, and in which, when occasion required, the fatigued champion rolled himself up and took his scanty repose. Of this we have a clear instance in the same tract, the Táin bó Cuailgne, in the case of Cuchulainn himself, its principal hero, on the day on which he first received the arms and admission into the order of the Knights of the Royal Branch. In compliance with what appears to have been an ordinary custom, the new knight, on the first day of his championhood, took one of King Conor's chariots, and drove to the border of the province, for the purpose of signalizing the occasion by some deed of valour against a neighbouring province. He directed his course southwards from Emania, crossed the border from Ulster into Meath, a little above Drogheda, on the Boyne, and drew up at the gates of Dun Neachtain Scené, [Skené] where he sounded a challenge, and then ordered his charioteer to spread for him the cloths or cushions (foirtce, *foirtché*), and the skins (forgaimin, *forgaimin*), of the chariot, in order that he might lie down and sleep until his enemies of the court, the sons of Scené, [Skené], should discover him and come to the attack. Instances of similar arrangement of the chariot furniture are frequently met with, so that the custom must have been general and not exceptional.

The following is the description of Cuchulainn's war chariot, in the Táin bó Cuailgne:—"Then did the valiant champion spring into his armed battle-chariot, (caṫċarbat serrda): with its thin swords; with its hooks, and hard spikes; with its champion-bending spears; with its opening machinery; with its

dealt the birds a *tath-beim*[8] of his sword, so that their feet and their wings clove to the water.

They caught them all then, and carried them away, and distributed them among the women, so that there was not a woman among them who did not receive two birds, but Eithne Inghuba alone. He came at last to his own wife. "Your spirits appear to be bad", said Cuchulainn to her. "They are not bad", said she. "Because (said he) it is by me the birds have been distributed among them". "Good reason you have", said she, "because there is not among them a woman who would not share her love and friendship with you; whilst as regards me, no other person shares my love, but you alone".

"Let not your spirits be low, therefore", said Cuchulainn, "for should birds come into the Plain of Muirtheimne, or upon the Boyne, you shall have the two most beautiful birds among them".

It was not long after until they saw two birds on the lake, linked together by a chain of red gold. They chaunted a low melody which brought sleep upon the assembly. Cuchulainn went towards them. "If you would listen to our advice", said Laegh (Cuchulainn's charioteer), and said Eithne, "you would not approach them"; "for", said she, "there is a power at the back of these birds; let birds be got for me besides them". "Is it possible that you question my word?" said Cuchulainn.

"Put a stone into that sling, Laegh" [said he]. Laegh then took a stone and placed it in the sling. Cuchulainn let the stone fly at them. It was an erring cast. "Woe and alas", said he. He took another stone, he let it fly at them, and it passed

galling sharp nails, which were disposed on the axles, and straps, and shafts, and ropes of that chariot. Thus was that chariot: with its thin (close), dry entrance to its body; high-mounted; straight-shouldered; champion-like, in which would fit the arms of seven chiefs; with the fleetness of the swallow, or of the wind, or of a fox over the course of a plain. That chariot was yoked upon two fleet, bounding, furious steeds; with small heads, small tufts, small legs, sagacious, broad-hoofed, red-breasted, switch-tailed, streaked, easy-yoked, easy of motion under the splendid timbers of the carr. One of these was swift, fleet-bounding, of great action, of flowing mane, vigilant, entire; the other steed, curly-maned, slender-legged, long-legged, narrow-hipped, sensitive", etc. etc.

Great cavalcades, or chariot progresses, are described in several of our ancient tales. Thus King Conor MacNessa goes to dine with the chief armourer of his court, and with the *elite* of his household, in fifty chariots. And again, we find that when Queen Méave pressed Ferdiad to fight Cuchulainn on her part (in the Táin bó Cuailgne), one portion of the great reward which was offered him was a chariot worth "four times seven cumals", that is worth eighty-four cows. And, again, the Saer carpait, or chariot builder, had his place of honour in the great banqueting-hall (teach miodcuarta), at Tara, where he ranked with the merchant (creacoir), and (in the distribution of the state repast) had for his joint of meat the "crooked bone".—[See "Petrie's "Antiquities of Tara", p. 179.]

[8] *Tath-beim*, that is, a vertical stroke.

dercóir etorro. Cansit céol mbec. Torċair cotlud forsinslóg. Atraig Cuculainn andoċum. Diacoistiṫe frim, orlaég, ocusolèthne, nírigṫá ċucu, aritá naċcumaċtu foracul nanénsa atetatar eóin damsa ċena. Indóig bátdom-eligudsaón, olCuculainn.

Gaibti cloiċ isintailm a Loíg. Geibti Loég iarom cloiċ ocusdobeir isintailm. Doslecı Cuculainn cloiċ foraib. Focairt imroll. Fe amaé olsé. Gaibid cloiċ naile. Dosléicdóib ocusluid seoċu. Amtrúsa tra, olse, ógabussa gaisced nirola imroll mourċur cussindiu.

Foċairt aċroisig forro colluid trésciaṫ nete in dala heóin lasodain. Lotair soalind.

Doṫaét Cúċulainn iarsin co tard adruim frisinliic ocusbaholc amenma leis, ocus dosuit cotlad fair. Conaccai in damnai cucai. Indalanai brat úaine impe, alaili brat corcra cóicdíabail imsude.

Dolluid inben cosinbrot úane ċucai ocustibid gen fris, ocus dobert beim dindeċsleisc do. Doṫaét alaili cucai dna ocus tibid fris ocusnodslaid fónalt cétna; ocus bátar fri ciana móir ocarsin .i. ceċtar dé immareċ cucai beus díabúalad, combomarb act bec. Lotir úad iarom.

Arigsitar Ulaid uli anísin ocus asbertatar aranduscide. Acc olFergus, naċingluarid resatċi.

Atraċt iarom tréna ċotlud. Cid dotrónad, olUlaid fris. Nirofet iarom anaccallaim.

Nomberar, forse domsergligu .i. don Teti Bricc, naba do Dún Imriṫ, nó do Dún Delca.

Notbertar dosaigid Emiri do Dún Delca, for Laég. Acc olse, mobreiṫ donTeti Bric. Berair ass iarom combói cocend mbliadna isinmaginsin cen labrad frineċ etir.

Laṫi nand resintsamfuin aile cind bliadna, ambátar Ulaid imbi isintaig .i. Fergus etir ocusfraigid; Conall Cernaċ etir ocus crand; Lugaid reóderg etir ocusadart; Etne Ingubai friaċossa.

Ambátar iarom, fónsamailsin tánic fer ċucu isateċ ocus deisid forsindairinniuċ naimdai imbói Cuculainn.

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9 *Teite Breac, i. e.*, the speckled palace. This was one of the three palaces of Emania, the chief city of ancient Ulster. The others were the Craebh-ruadh, or Royal Branch, and the Craebh Dhearg, or Red Branch.

10 *Dun Imrith.*—The exact situation of this place is unknown, but it must have been in Muirtheimne, and one of Cuchulainn's own residences.

11 *Dun-Dealga*, now Dundalk, in Muirtheimne, and Cuchulainn's chief ancestral residence. It had its name from Dealga, a chieftain of the Firbolgs, who built it.

them. "I am a wretch", said he; "since I have first taken arms, I have not made an erring throw until this day".

He then threw his heavy spear [croisech], and it passed through the flying wing of one of the birds. They plunged under the water.

Cuchulainn went away then in bad spirits, and put his back to a rock, where sleep soon fell upon him. And he saw [through his sleep] two women coming towards him. One woman had a green cloak, the other had a five-folded crimson cloak on.

The woman with the green cloak went up to him, and smiled at him, and she gave him a stroke of a horse switch. The other went up to him then and smiled at him, and struck him in the same manner; and they continued for a long time to do this, that is, each of them in turn striking, until he was nearly dead. They went away from him then.

All the Ultonians perceived what had happened, and they asked if they would awaken him. "No", said Fergus, "do not move him before night".

Cuchulainn stood up afterwards through his sleep. "Who has thus used you?" said the Ultonians to him.

He was not, however, able to converse with them.

"Let me be brought", said he afterwards, "to my bed of decline, namely, to the Teti Breac,[9] not to Dun Imrith,[10] nor to Dun Delca".[11]

"Let him be brought to [his wife] Emer, to Dun Delca", said Laegh. "No", said he, "let me be brought to the Teti Breac". He was then carried there, and he continued to the end of a year in that place without speaking to any one.

One day before the next November, at the end of the year, the Ultonians were around him in the house, namely Fergus, between him and the wall, and Conall Cearnach between him and the door; Lugaidh Reo-derg between him and his pillow [holding him up]; and Eithne Inghuba at his feet.

As they happened, now, to be thus situated, a man came into the house to them, and sat on the front rail of the bed in which Cuchulainn lay.

"What has brought you there?" said Conall Cearnach. "I will tell", said he: "if the man who is here were in health, he would be a protection against all the Ultonians; and in the great illness and debility in which he now is, he is the more a protection against them". "I fear nothing", said he, "because it is to converse with him I have come". "You are welcome, you need fear nothing", said the Ultonians. He then stood up and sang for them these verses:—

Cid dottucai andrin olConall Cernaċ. Nin. olse. Mád-inaslánti indfir fil sund robad ċomairċe arUltaib ulib. Inidilobrai ocus iningár dona atá ismóode as comairċe airṫiu. Niagur neċ iarom uair isroiaacallaim do deoċad. Taṫut faelte, niáigṫer ní, olUlaid. Atraig iarsin innaseram ocus gabair doib innarundura sis iarom.

A Cuculaind fotgalar,
Nibo sirsan intanad,
Noticfitis diamtislat,
Ingena Aeda Abrat.

Asbert Liban immaig Cruaiċ,
Bís fordeis Labrada luaiṫ,
Robad cridiscel la Faind,
Coibligi fri Coinculaind.

Robad inmain lá mádfír,
Ricfid Cuculaind moṫir,
Rambiad arcut ocus ór,
Rombiad mór fina doól.

Diammadċara dam cose,
Cuculaind mac Soalte,
Inatconnarc inasuan,
Bes atcoad cenasluag.

Immaig Murṫemni sunt tess,
Aidċi samna nibamles,
Domficfe uaimse Liban,
A Cuculaind cotgalar,
A Cuculaind.[12]

Coiċ ṫussu, oliat. Meisi Oengas mac Aeda Abrat olse. Luid uadib iarom infer ocusnífetatar ciadeoċaid no can donluid. Atraig Cuculainn inasudi iarom ocuslabrais iarsin.

Bamiṫig ém, olUlaid, anisin, isniċ cid andotrónad.

At connarc ém olse aislingi immonsamain innuraid. Adfet dóib uli amail atċonnairc.

Cid dogéntar disund a popa Choncobair, olCuculainn. Dogéntar, olConcobar, orta cosís in corṫe cétna.

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[12] All ancient Gaelic poems end with the word or words with which they begin, and when this is the case, the poem is presumed to be perfect; sometimes, however, more than one stanza, towards the end of a poem, ends designedly with the first word, as will be seen farther on.

"O Cuchulainn! in thy illness,
Thy stay should not be long;
If they were with thee,—and they would come,—
The daughters of Aedh Abrat.

Liban, in the plain of Cruaich, has said:—
She who sits at the right of Labraid the quick,—
That it would give heartfelt joy to Fand
To be espoused to Cuchulainn.

Happy that day, of a truth,
On which Cuchulainn would reach my land;
He should have silver and gold,
He should have abundance of wine to drink.

If my friend on this day should be
Cuchulainn, the son of Soalté,
All that he has seen in his sleep
Shall he obtain without his army.

In the plain of Muirthemne, here in the south,
On the night of Samhuin, without ill luck,
From me shall be sent Liban,
O Cuchulainn, to heal thy disease.
O Cuchulainn!"[12]

"Who are you?" said they. "I am Aengus, the son of Aedh Abrat", said he. The man then departed from them, and they knew not whence he came, nor where he went to. Cuchulainn then sat up and spoke.

"It is time, indeed", said the Ultonians; "relate to us what has been done".

"I saw", said he, "a vision about this time last year". He told them then all that he had seen.

"What shall be done now, my master, Concobar?" said Cuchulainn. "This shall be done", said Concobar; "you shall go now until you reach the same rock".

Cuchulainn went forth then until he reached the same rock, when he saw the woman with the green cloak coming towards him. "That is well, Cuchulainn", said she. "It is not well, indeed; what was the object of your visit to us last year?" said Cuchulainn.

"It was not to injure you, indeed", said she, "that we came, but it was to seek your love. I have come now to speak to you", said the woman, "from Fand, the daughter of Aedh Abrat, who

Luid Cuculainn assiarom coránic incorṫe, conaccai inmnai bruitúani ċucai. Maiṫ sin a Cuculainn olsi. Nímaiṫ dna, ém, cid forturusri ċucund innuraid, olCuculainn.

Nídu forfogail ém olsi, do deoċammarni, aċt isdoċuinċid forcaratraid. Dodeoċadsa ém, dotacallaimsiu, olinben, o Faind ingin Aeda Abrat, rosléci Manandan mac Lir; ocus do rat serc duitsiu iarom. Liban dna, mainmse féin. Timarnad duit iarom, óm céliu, oLabraid Luaṫ Lam arclaideb. Dobéra deit inmnai ardebaid noénlai leis frisSenaċ siaborṫe, ocus frisEcdaig niúil, ocus fri Eogan ninbir.

Nimṫa maiṫ em, olse, doċaṫ frisiru indiu. Bidgar úar anisin, orLiban, bia slan ocusdoformastar deitandotesta ditnirt. Is denta dait ar Labraid anisin, arise laéċ asdeċ diocaib domain.

Ciri airm hitaside, for Cuculainn. Itá immaig Mell olsi.
Is ferr damsa teċt leṫ naill olindingen. Taét Laeg lat, olCuculainn dfis intiri asatudċad. Taet iarom o[l]Liban.

Lotar iarom, coráncatar coairm imboí Fand. Tic iarom, Liban diasaigid Loíg, ocusgeibṫi arsúalaind. Niraga ass tra, aLoig olFand,[13] indiu imbeṫu aċt menitainge ben. Ni boéd as mó rognáṫaigsem dún custraṫsa, for Loeg, bancomarċi. Appraind ocus biṫappraind naċ hé Cuculainn sil itriċt indossa, or Libar Bádmaiṫ limsa dna, combad hé nobeṫ and, forLaég.

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[13] *Recte* Liban.

[14] *Manannan Mac Lir.*—Manannan, the son of Ler, the great Tuath de Danann chief, merchant, and navigator, whose chief residence was Inis Manannain, or Manainn, that is, Manannan's Island, now corruptly called the Isle of Man.

[15] *Eoghan Inbhir*, that is, Eoghan of the River's Mouth. The River's Mouth mentioned here is, I believe, Inbher Mor, the mouth of the river Abhainn Mhor, in the county of Wicklow, where the town of Arklow stands. This identification of Eoghan Inbhir is derived from the Book of Leinster, folio 5, where it is stated that Fiachna, a son of Delbaeth, monarch of Erinn, and the six sons of Ollam, were slain by Eoghan of Inbher Mor. They were all of the Tuath De Danann race, and this event, according to the chronology of the Annals of the Four Masters, occurred, A.M. 3470.

[16] *Magh Mell*, that is, the plain of happiness. This was one of the mythological names of the Elysium or Fairy-land of the ancient Gael.

[17] *The Island*—This was Inis Labraid or Labraid's Island, the exact position of which is not, as far as I know, ascertained. The name occurs twice in the Annals of the Four Masters; firstly, at the year of our Lord 919, where it is stated, that the Danish prince, Goffraigh, the son of Imar, plundered the city of Armagh, and the country all round it, westward as far as Inis Labrada, and eastward as far as the river Banna, etc.; and secondly, it is stated under the year 1108, that Inis Labrada was demolished by the Feara-Manach (the people of Fermanagh). It is evident from this record that Inis Labrada, at the time mentioned, was a fortified place, and it is very probable that it was situated in Loch Erne.

has been abandoned by Manannan Mac Lir,[14] and she has conceived an affection for you. Liban, indeed, is my own name. I have a message for you, too, from my husband, Labraid of the quick hand at sword. He will give you the woman on your giving him one day's aid in battle against Senach the distorted, and against Eochaidh n-Iuil, and against Eoghan Inbhir".[15]

"I am not well enough, indeed", said he, "to make battle against men to-day". "Short is the time that that shall be the case", said Liban; "you shall be healed, and what has been lost of your strength shall be restored to you; and you ought to do this for Labraid, because he is the noblest of the champions of the world".

"In what place is he?" said Cuchulainn. "He is in Magh Mell [plain of Mell]",[16] said she.

"I had better be going elsewhere", said the woman. "Let Laegh go along with you", said Cuchulainn, "to examine the land from which you have come". "Let him come then", said Liban.

They went forward then until they reached [*recte*, to reach] the place in which Fand was. Liban then went up to Laegh and caught him by the shoulder. "You shall not escape, O Laegh, this day", said Fand [*recte*, Liban], "unless you are protected by a woman". "That is not what we were most accustomed to hitherto," said Laegh, "woman-protection". "Alas, and eternal alas! that it is not Cuchulainn that is in your place now", said Liban. "I would be glad that it were he that were there", said Laegh.

They went away then until they arrived by the side of the island.[17] They saw the little copper ship upon the lake before them. They then went into the ship, and they went into the island, and they went to the door of a house; they saw a man coming towards them, and Liban said unto him:—

"Where is Labraid of the quick hand at sword
Over victorious troops;
Victorious in the body of a strong chariot,
He looks upon bloody spears?"

The man answered her then, and said to her:—

"Labraid is quickening clanns,—
It is not slow he is ever in good,—
Assembling a battle, a slaughter will be made,
Of which the plain of Fidghae will be filled".

They went then into the house; and they saw three times fifty

Lotar ass iarom conrancatar toéb naindse. Conaccatar in Lungine créduime forrindloċ aracind. Tiagait iarom, isin-Lungu ocus tiagait isinninsi, ocus Lotar dodorus tige, conac-catar infer ċuċu; is and asbert Líban fris:—

> Cate Labraid Luaṫ Lám ar claideb,
> Arcend mbuidenmbuada;
> Búaid úasċret ċarpait glinni,
> Dercas rinni ruada.

Frisgart dissi infer iarsin conepert so fria:—

> Atá Labraid Luiṫe cland,
> Nibamall bid imda.
> Tinol caṫa cuirṫer ár,
> Díabalan Mag Fidgae.

Tiagait iarom isateċ, conaccatar trí coécto imdad istig, ocus trícoícait ban indib. Fersait ule faélti frí Loeg. ISed asbertatar uli fris: Foċenduit a Loig diag [*recte* daig] neiċ lastudċad ocus otudċud, ocus ditdáig ferni.

Cid do gen a feċtsa a Loig, for Líban, inraga doacallaim Fainde coléic. Ragat act cosíasur innairm atá. Nin. Atá inairicul foleiṫ, ol Líban. Lotar iarom, díahacallaim, ocus feraisside faélti friú foninnas cétna.

Fand din, ingen Áeda Abrat .i. Áed tene, is hé tene na súla inmac imlesen; Fand iarom, ainm na dére dotaet tairis. Araglaini roainmniged disi sin, ocus aracoími, arníboí isin biṫ frisa samailte ċena.

In tan mbátar and iarom, cocualatar culgaire carpait Labrada dundinsi. Isolc menma Labrada indiu, ol Liban. Tiagam dia accallaim. Tiagait ass immaċ ocusferais Liban faelti fris, conepert:—

Foċen Labraid Luaṫ Lam arclaideb, comarbae buidne, snede slegaige, slaidid sciaṫu, scailid gou, créċtnaigid curru, gonaid soéru, saigid oirgniu, aildiu innaib, manraid sluagu, sreid muine, fobartaċ sían foċhen. Fochen Labraid.

Nissfrecart Labraid beus, ocus asbert indingen aṫeruċ:—

Foċen Labraid Luaṫ Lám arclaideb augra, urlam doraṫ, rurteċ do ċáċ, saigteċ do caṫ, créċtaċ aṫoéb, cundail abria-ṫar, brígaċ aċert, ċartac aslaiṫ, Láimteċ ades, diglaċ agus, tinbeċ laeoċu, Labraid foċen. Foċen Labraid.

Niroregart beus Labraid; canaidsi laíd naili assfridissi:—

Foċen Labraid Luaṫ Lam ar claidem, laeċdu ócaib, uallċu murib, manraid gossa, gniid caṫu, criaṫraid ócu, tocbaid Lo-bru, tairnid triunu, foċen Labraid. Fcċen Labraid.

couches in the house; and three times fifty women on them. They all bid welcome to Laegh. This was what they all said to him: "Thou art welcome, Laegh, on account of the person with whom thou hast come, and from whom thou hast come, and on thine own account".

"What wilt thou do now, O Laegh?" said Liban; "wilt thou go to talk to Fand at once?" "I will, if I but know the place that she is in" [said Laegh]. "I will tell thee: she is in a separate chamber", said Liban. They went then to converse with her; and she bid them welcome after the same manner [as above].

Fand, now, was the daughter of Aedh [Hugh] Abrad, *i.e.*, aedh is fire, the fire of the eye is the pupil. Fand, then, is the name of the tear which passes over it. It was for her purity she was so named, and for her beauty; for there was nothing in life with which she could be compared besides it.

As they were thus there, they heard the rolling of Labraid's chariot coming to the island. "Labraid's spirit is bad to-day", said Liban; "let us go to salute him". They then went out, and Liban bid him welcome, and said:—

"Welcome, Labraid of the quick hand at sword; the representative of legions; the shooter of light spears; the cleaver of shields; the scatterer of heavy spears; the wounder of bodies; the slayer of nobles; the seeker of slaughters; most beautiful in appearance; destroyer of hosts; scatterer of wealth; assaulter of champions; welcome, welcome, Labraid!"

Labraid did not yet speak, and the maid said again:—

"Welcome, Labraid of the quick hand at battle-sword; ready his stipend; munificent to all; seekful of battle; wounded his side; faithful his word; rigorous his justice; benign his sovereignty; strong his right arm; avengeful his deed; gentle to his steeds; Labraid, welcome; welcome, Labraid".

Labraid still did not answer: she spoke another lay again:—

"Welcome, Labraid, of the swift hand at sword; most valiant of warriors; haughtiest of chiefs; destroyer of strength; fighter of battle; exterminator of champions; elevator of the weak; subjugator of the strong; welcome, Labraid; welcome, Labraid".

"What you say is not just, O wife!" said the man Labraid; and then he said:—

"It is not haughtiness nor pride, O wife, nor a high spirit of happiness, that confuses our senses: a battle approaches, of double-edged spears many, of dangerous plying of red swords upon the fists of right and left hands; [equal to] many is the one heart of Echaidh Iuil: we cannot have any haughtiness. It is not haughtiness, it is not pride in me, O wife!"

"Your spirits will be good indeed", said the wife, said Liban,

Nímaiṫ anasber aben olintí Labraid, conid and asbert:—

Niual nahúabur dam aben, naċardarcnid mellċai mescṫair arcond, reċmi caṫ nimrind nimda, nimamnas imberta claideb nderg ardornaib, desaib, tuaṫaib; ilib oenċridiu Eċdaċ Iuili, nitanbí naċ núall. Níuall níuabar dam aben.

Badmaiṫ lat do menma tra olinben, orliban frir, atá Loég, ára Conculaind sund ocus timarnad duit úad doticfa slóg uad. Ferais Labraid faélti fris iarom anasbert:—

Foċen duit aLaíg fobiṫ namná lastánac ocus inċáiċ otudċad.

Dó duit do tig, a Laíg, orlabraid, ocus ragaid Líban itdiaid.

Tic Laeg asriarom coEmain ocus atfet ascéla do Conculainn ocusdoċaċ olċena.

Atraig Cuculainn iarsin nasudi ocusdobert láim daraagid, ocusacallais Laeg co glé, ocus banertiti leis amenma na scéla adfiadar do ingilla.

Bai dna, terċomrac occetri ollċoecedaib hErenn indinbaidsin dus infaigbitisneċ bad toga leó diatibertis rigi nErend. Uair bá holc leó tilaċ airecais ocus tigernais hErenn .i. Temair, abiṫ cenreċtgi ríg furri, ocus báolc leó na tuaṫa censmaċt rig occocertad acotrebi. Arbátar fir hErenn censmaċt rig forro frise. uii. mbliadan iarndiṫ Conaire imBruidin Daderca cussinmordailsin cetri coiced nErend hi Temraig na rig, hitig Erc mic Corpri Niad Fer.

Atiat so imorro, rig batar isindailsin. i. Medb ocus Ailill, Curoi ocus Tigernaċ Tétbannaċ mac Luċtai, ocus Find mac Rossa.

Nidentáis iarom indfirsea comairli ríg friUltu fobiṫ arisdoenoentaib bátar indfirse hicend Ulad.

Dognitér iarom tarbfes leo andsin co fiastais esti cia diatibertais rigi.

Isamlaid dognite intarbfessin .i. tarb find domarbad ocusoenfer docaṫim asata dia eóil ocusdáenbruṫi, ocus cotlud dó fónsaiṫsin ocus or firindi do cantain do ċetri druidib fair, ocus atċite dó inaslingi innas indfir no rígfaide and asadeilb ocus asatuarascbail ocus innas indoprid do gniṫ. Diuċtrais infer asaċotlud ocus adfiadar ases donarigaib .i. moéṫoclaeċ saer, sonairt, condácrus derca tairis, ocus sé osadart fir isirc inEmain Maċa.

Faiditer iarom tecta frisin coEmain. Isandsin batar Ulaid inaturċomrac im Choncobar inEmain intansin, ocus Cuculainn inasersligu and. Atfiadat ascéla do Choncobar ocus do maṫib Ulad olċena

[18] Conairè Mor, monarch of Erinn, was slain by British and Irish outlaws, at Bruighean Da Derga, near Dublin, A.M. 5160.

to him: "Laegh, Cuchulainn's charioteer, is here, and has a message for you from him to say that he will join you in your expedition". Labraid then bade him welcome, and said:—

"Thou art welcome, O Laegh, for sake of the woman with whom thou hast come, and the man from whom thou hast come. Return thou to thy home, O Laegh", said Labraid, "and Liban shall go after thee".

Laegh came away then to Emania, and he told his story to Cuchulainn and to all besides.

Cuchulainn then rose up, and he passed his hand over his face; and he pleasantly conversed with Laegh, and he felt that the stories which the youth related to him were a strengthening to his spirits.

There was, now, a meeting of the four great provinces of Erinn held at this time, to see if they could find a person whom they would select, to whom they would give the sovereignty of Erinn; because they deemed it an evil that the Hill of Supremacy and Lordship of Erinn, that is Tara, should be without the rule of a king upon it; and they deemed it an evil that the tribes should be without a king's government to judge their houses. For the men of Erinn had been without the government of a king over them during a period of seven years, after the death of Conaire,[18] at Bruighean Da Derga, until this great meeting of the four provinces of Erinn, at Tara of the Kings, in the court of Cairbre Niafear.

These, now, were the kings who were in that meeting, namely, Medbh and Ailill, Curoi, and Tighernach Tetbannach, son of Luchta, and Finn Mac Rossa.

These men, now, would not hold counsel for [the election of] a king with the Ultonians, because these men were of one accord opposed to the Ultonians.

There was then prepared a bull-feast by them there, in order that they should discover out of it to whom they would give the sovereignty.

Thus was that bull-feast prepared, namely: a white bull was killed, and one man eat enough of his flesh, and of his broth; and he slept under that meal; and a charm of truth was pronounced on him by four Druids; and he saw in a dream the shape of the man who should be made king there, and his form, and his description, and the sort of work that he was engaged in. The man screamed out of his sleep and described what he saw to the kings, namely, a young, noble, strong man, with two red streaks around him, and he sitting over the pillow of a man in a decline in Emain Macha [Emania].

A message was then sent with this description to Emania.

Fillinni mac saer, soceneóil fonsamailsin, ol Concobar .i. Lugaid reóderg, mac na Trifinnemna, dalta Conculainn fil osadart na himda ṫall amne ocurgartigud a aiti .i. Conculainn fil hisirg.

Atraig Cuculainn andaide ocus gebid fortecosc adaltai, conidand asbert:—

BRIATHARTHECOSC CONCULAIND INSO.

Nirbat taerrectaċ debṫa dene doér gairce. Nirbat distir, dóiċleċ, diummasaċ. Nibbatecal, ocal, opond, esamain. Nipat tairne ómain mandarṫa mescṫa. Nibat dergnat colla coirme hitig rurech. Niabatilfurig imírand neċtrand. Nisaís daine doclu diċumaing. Niíadat iubaili forétectu ail. Airliter cumni cóiċ comarbai cré. Cuibrigter sencaid sin cofirinne fiu hitfiadnairi. Finnatar beṫamain braṫir sceo mbroga. Mrogatar genelaigi ges, ci uagenitter gein. Gairter. Bíbeodaigter frioétu. Airm irrotrebrat mairm. Mainigter comarbai foraṫeċtu ṫoiċ. Tocomlaat anfini coa nemṫe nert.

Nisserserea colabur. Niaisneisea coglóraċ. Nísuirse. Níċuitbe. Nisaitċiter senori. Nipá mitomtinaċ oneoċ. Nigéis co andsa. Niettis neċ cenadomanċes. Cáin ois. Cáin éra. Cáin airlice. Bát umal múnta ógaéṫaib. Batcumneċ coisc ótsenaib. Bátseiċmeċ riagla aṫardai. Nipat úarcraideċ im ċardiu. Batgusmar imnaimtiu. Nipassriṫeneċ debṫa hitilċompaicib Nirbat scelaċ, aṫcossanaċ. Nisaisce. Niċaisce ni níbatorba Consceċa docúrsaċad ignimaib antectai. Niċomainse ṫirinne artoil daine. Nibataṫboingid arnarbataiṫreċ. Nibatcomromaċ arnabatmirscneċ. Nirbat lesc ar narbat meirb. Nirbat roescid arnabatdoescair. Ardotċuibdig friseċem nambriaṫarsin a mic?

Isand asbert Lugaid insoris frí Coinculainn.

Eo asmaiċ, ambiċ ule;
Arinfestar caċdune;
Noco teseba ni de;
Firfaider madurise.

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[19] '*An ale-polluting flea*'.—This sentence, like almost all the sentences of this difficult speech, contains an allusion to forms of expression used in the Laws, which it would require too much space to explain at length in a note here; all these allusions will, however, become fully intelligible when the great work in preparation by the Royal Commissioners for the publication of the "Brehon Laws" makes its appearance. The general meaning of the sentence is but an exhortation to the young king, to avoid being led into intemperance at the

The Ultonians at the time were assembled around Concobar in Emania, and Cuchulainn in his decline there. He [the messenger] related his story to Concobar, and to the nobles of Ulster also.

"There is with us a free and nobly descended youth of that description", said Concobar, "namely, Lugaidh Reoderg, the son of the Three Fair Twins; the pupil of Cuchulainn; over whose pillow he sits in his bed within, by himself, solacing his tutor, that is Cuchulainn, who is in his bed of decline".

Cuchulainn rose up [then] and began to instruct his pupil, upon which he said.—

The Verbal Instruction of Cuchulainn.

"You shall not be a terrified man in a furious, slavish, [oppressive, severe,] fierce battle. You shall not be flighty, inaccessible, haughty. You shall not be intractable, proud, precipitate, passionate. You shall not be bent down by the intoxication of much wealth. You shall not be an ale-polluting flea in the house of a provincial king.[19] You shall not make many feasts to dispense to foreigners. You shall not visit disreputable people, incapable [of entertaining you as a king]. You shall not let prescription close on illegal possession.[20] Let witnesses be examined of who is the heir of land. Let the historians[21] combine in truthful action in your presence. Let the lands of the brethren be ascertained in their lifetime, and their increase. If generations have multiplied in branches, whom has each been generated from? Let them be called up; let them be revived on oath [that is, their ancient claims reëstablished on oaths]. The place that the dead [their ancestors] have resided in. Let the heir be preserved in his lawful possession. Let the strangers be driven off it [the patrimony] by the strength of battle.

"You will not relate garrulously. You will not discourse noisily. You will not mock, you will not insult, you will not deride old people. You will not be ill-opinioned [you will not suppose ill] of any one. You will not make difficult demands. You will not refuse any one for his cow. [You will have] a law of lending, a law of extortion, a law of pawning. You

feasts prepared for him by the provincial kings, during his state visits to the different provinces of Erinn.

[20] *You shall not let prescription close on illegal possession.* This is in accordance with the "Brehon Laws", which enacted, that no matter how long a term during which land might be illegally or secretly obtained and overheld, it should not amount to prescription.

[21] *Let the historians combine.*—This also was enacted by the "Brehon Laws".

Luid Lugaid iarsin frisnatechtaib coTemraig ocus gongarar garm rigi do, ocus fais hi Temraig indaidchisin; ocus luid cach diamennat iarsin.

IMTHUSA IMMORRO, CONCULAINN ISSED ADFIASTAR SUND COLEIC.

Do duit úaim a Laíg, for Cuculainn, coairm hitá Emer, ocus innis condat mnasídi romthathigset, ocus romadmilset, ocus apair fria isferr achác itosa ocus taét domindnaigid.

Is and Asbert ingilla ocnertad Conculainn inso:—

Mór espa do laech laigi frisúan serglige, ardo nadbat genaiti (.i. mna) aésa, atenmag trogaigi (.i. a maig mell), condotrodbsat condotchachtsat, condotellatetar briga banespa. Diuchtra (.i. eirig) aterbaig andregoin (.i. agalar bansidi), ar dotaét do lochbríga (.i. do laech briga) eter argaib erritib (.i. anradaib), condotruidi sudi nóg, condotchellti (.i. conderna), condotchiúrthi margnímu, diasocart lúth labrada, afirrudi, atraí coropatmór. Mór espa.

Téit ingilla iarsin coairm imboí Emer ocus adfet amail boí Cuculainn.

Olc duitsiu agilli forsi, aristú taithiges insíd cenfeib íca do tigerna dagbáil lat. Truag dUltaib, forsi, censirthin a márica. Diambad Conchobur credbaigte, no Fergus níthastar súan, no Canall Cernach tabsat crechta, is Cuculainn cobarthe.

Cachainsí iarom laíd Lasodain fon chrutsa:—

Amic Riangabra forír,
Cidmenic imthigi insíd,
Nimoch doroich let ille,
Icc mic delba Dechtere.

Truag dUltaib colín garta,
Etir aite iscomalta,
Censirriud indomain-duind,
Dícc acarat Conculaind.

Madfergus nobeth [*recte*, nadbeth] issuan,
Dániccad aicned oendrúad,
Níbíad mac Dechtere ifos,
Cofagbad drui diatomos.

Diámbad hé Conall chena,
Frismbet crechta iscneda,
Nosirfed in Cu inmith (mbith) mbras,
Cofagbad liaig daleges.

will be obedient to the teaching of the wise. You will be recollective of the instructions of the old. You will be a follower of the rules of your fathers. You will not be cold-hearted to friends. You will be strong to your foes. You will not be a retorter of abuse in your many battles. You will not be a tattler and abuser. You will not waste; you will not hoard; you will not alienate. You will bear to be reproved for unbecoming deeds. You will not sacrifice your truthfulness to the will of men. You will not be a releaser [*namely, of bondmen and prisoners without security taken for them*], that you be not repentant. You will not be a competitor, that you be not jealous. You will not be lazy, that you be not inert. You will not be too importunate, that you be not mean. Do you consent to follow these words, my son?"

Then Lugaidh spoke as here below to Cuchulainn:—

> "As long as it is well, they shall be all kept;
> For every one shall know
> That nothing shall be deficient of it;
> It shall be verified, if practicable".

Lugaidh then repaired, along with the messengers, to Tara, and he was proclaimed as king; and he slept in Tara that night; and after that, all [the assembly] returned to their homes.

The Story of Cuchulainn is what is told here now.

"You are to go from me, O Laegh", said Cuchulainn, "to where Emer is, and tell her that it was women of the hills [fairy women] that came to me and injured me, and tell her that I am getting better and better, and to come and reside with me".

Then the servant said, to strengthen Cuchulainn, what follows:

"It is great idleness in a champion to yield to the sleep of a bed of decline, because genaiti (*i. e.* women) from Ten-mhagh Trogaighi (*i. e.* Maigh Mell,) have appeared to you, who overcame you, who manacled you, who bound you within the power of idle women; start (*i. e.* arise) out of death (*i. e.* disease), by maidens wounded (*i. e.* by women of the hills), for all your strength has come (*i. e.* champion strength), among warrior chiefs (*i. e.* heroes), until you rush to the place of warriors—until you have done (*i. e.* performed)—until you have achieved mighty deeds, where active Labraid leads his rushing men. Arise! that you may be great". It is great idleness.[22]

[22] The first words of the speech repeated; as customary with the scribes of old, to show where the piece or poem ends.

Mád do Láegaire búadaċ,
  Tisad ág bádimuallaċ,
  Nosirfed hErind naníaċ,
  Díc mic Connaid mic Iliaċ.

Dambad do Cheltċair na celg,
  Tisad súan ocussírḟerg,
  Robad artraċ aidċi isla
  Etir sídaib Setantá.

Dambad Fuirbaidi na fian,
  Nobeṫ illige lanċían
  Nosi rfed indomon ndoron
  Cosagbad aṫesarcon.

Atbaṫsat slúaig síde Truim,
  Roscarsatar amorgluind,
  Níṫét accu [*recte* ancú] darcona,
  Orogab súan síṫ Broga.

Uċan dogalur nomgeib,
  O Coin ċerda Conċobair,
  Isaéṫ remċride issremcnes,
  Díatísad dím aleges.

Uċan iscrú moċride,
  Serg formarcuċ inmaige,
  Connátorraig sund ille,
  Dóenuċ muge Murṫemne.

ISde nátic ahEmain,
  Dáig nadelba rondedail,
  Ismerb isismarb moguṫ,
  Dáig atasom fodoroċruṫ.

Mi ocusráṫe ocusbliadain,
  Cenċotlud fóċomriagail,
  Cen duini badbind labra,
  Níċuala amic Riangabra.
        Amic Riangabra.

Tanic Emer rempi cohEmain iarsin dinnaigid Conculaind, ocus dessid issindimdai imbai Cuculaind, ocusrobai cárád; Ismebul duit orsi, laigi fribangrád, uair dogenad galar duit sírligi, ocusbai caacallaim ocusroċan laíd:—

The servant went then to where Emer was, and told her how Cuchulainn was.

"Bad of thee, O servant", said she, "since it is thou that frequentest the hills, that the means of curing thy master are not procured by thee. It is a pity for the Ultonians", said she, "not to seek his perfect cure. Had it been Concobar that was in bonds, or Fergus that could not sleep, or Conall Cearnach who had received wounds, it is Cuchulainn that would relieve them".

She then sang a lay after this manner:—

O Son of Riangabhra, alas!
Though often you visit the hill,
Not early have you hither brought
The cure of the beautiful son of Decteré.[23]

Pity the Ultonians, of boundless valour,
Both in tutors and in pupils,
Not to have searched the world's expanse
For a cure for their friend Cuchulainn.

If it were Fergus that could not sleep,
And that any Druid's skill could heal him,
Decteré's son at home would not sleep
Until he had found a Druid to perform it.

If it were Conall, in like manner,
That suffered from wounds and sores,
The Hound [Cuchulainn] would search the world wide,
Till he had procured a doctor to cure him.

If upon Laeghaire Buadhach [the gifted],
There had come battle [wounds] intolerable,
He would have searched all Erinn's land
To cure the son of Connaid, son of Iliach.

If it had been upon the vindictive Celtchair,
There fell sleep and permanent sickness,—
Both night and day should see the journeys,
Among the hills, of Setanta.[24]

Had it been Furbaidhe, chief of warriors,
That lay in his bed of tedious illness,

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[23] *Decteré.*—She was Cuchulainn's mother, and sister of Conor Mac Nessa, King of Ulster.

[24] Setanta was Cuchulainn's first name.

He would have searched the convex world
Until he had found what would save him.

The [fairy] host of the hill of Trim[25] has killed him,
They have parted him from his great valour,
The Hound [Cuchulainn] does not excel hounds,
Since he caught the sleep of the hill of Brugh.[26]

Uchone, with sickness I am seized,
For the Hound [Cuchulainn] of Concobar's smith,[27]
It shall be to me a sickness of heart and of body,
Should I not succeed in effecting his cure.

Uchone, it bleeds my heart,
That illness should rest on the rider of the plain,
That he could not have hither come
To the Fair of the plain of Murtheimne.

The reason why from Emania he comes not, is
Because of the [noble] form with which he has parted:
It is weak and dead my voice is,
Because that he is in a bad condition.

A month, a quarter, and a year
Without sleep—it is my fixed rule,
And no person whose words were sweet,
Have I heard, O son of Riangabhra.
O son of Riangabhra.

Emer then went forward after this to Emania to attend on Cuchulainn; and she sat in the bed in which Cuchulainn was, and she was saying: "It is a disgrace to you", said she, "to lie down for a woman's love; because constant lying down will bring illness to you"; and she continued to converse with him, and she spoke a poem:—

[25–26] Ancient fairy hills and palaces on the left bank of the River Boyne, above and below Slane.

[27] Culann was the name of Conor Mac Nessa's smith, and it was from him that Setanta derived the name Cu-Chulainn, or Culann's hound.

[*To be concluded in the next number.*]

SCIENTIFIC RESEARCHES.

Art. I.—*On an Inequality of long period in the motions of the Planets Jupiter, Saturn, and Uranus.* By Rev. W. G. Penny, M.A.

In consequence of the fact that the quantity $2n_4 - 6n_5 + 3n_6$, or 813″, is small with respect to the mean motions of each of the abovenamed planets, there will arise in the motions of each of them an inequality of long period; and besides this, there will be corresponding inequalities whose periods are nearly the same as those of the revolutions of the several planets.

I have adopted the elements of the planets given by M. Pontecoulant; as also their secular variations. A different value of the annual progression of the perihelion of Uranus to that here used is sometimes given; and if it were adopted in this instance, the inequalities of Saturn and Uranus would be somewhat greater than here found; but probably M. Pontecoulant's value is the more correct one.

To find then the inequalities in the motions of Uranus and Saturn arising from their direct mutual perturbation, it will be necessary to substitute in the disturbing function which relates to them, the following inequalities in the motion of Saturn which arise from the direct perturbation by Jupiter.

$$\theta = (23154'' - t\,1''.2) \sin (q_5 - \varpi_5)$$

$$+ 811.9'' \sin (2q_5 - 2\varpi_5)$$

$$-(652.59 - .038''t) \sin (2q_4 - 4q_5 + 59^\circ.34' - 60.7''t)$$

$$-24.37'' \sin (2q_4 - 3q_5 + 20^\circ.45')$$

$$-31.89'' \sin (2q_4 - 2q_5)$$

$$-(2906.6'' - .114''t) \sin 5\phi_5 - 2\phi_4 + 3^\circ.38' - 76''t)$$

$$r=9.5577-0.5349\cos(q_5-\varpi_5)$$

$$-.015\cos(2q_5-2\varpi_5)$$

$$+(.01479--.00000075t)\cos(2q_4-4q_5+58^\circ.28'-63''t)$$

$$-.00155\cos(3q_5-2q_4+38^\circ.55')$$

$$+.0014\cos 2q_5-2q_4)$$

$$+.00095\cos(5q_5-2q_4+32^\circ.32')$$

where ϕ_5, etc. $=nt_5+\epsilon_5$, and

$q_5=n_5t+\epsilon_\varepsilon+$the inequalities of long period which occur in the motions of Saturn.

By exactly the same process as that followed in a previous number, these quantities will produce terms which, when put into combination, give for Uranus the inequality

$$\delta\theta=(43.371''-.0024''t)\sin(3\phi_6-6\phi_5-2\phi_4+7^\circ.52'-68''t)$$

and for Saturn the inequality

$$\delta\theta=-(11.869''-.00074''t)\sin(3\phi_6-65_5\text{-}2\phi_4+8^\circ.32-68''t).$$

Also there are in the coördinates of Saturn the following quantities arising from the direct perturbation of Uranus.

$$\delta\theta=(29.66''-.00195''t)\sin(2q_5-3q_6+24^\circ-1''t)$$

$$+(3.084''-.00017''t)\sin(3q_5-3q_6-38^\circ.6'-5't)$$

$$-.254''\sin(4q_5-3q_6+58^\circ.2)$$

$$+30.89''\sin(3\phi_6-\phi_5-87^\circ.28')$$

$$\delta r=(.00066-.000000009''t)\cos(2q_5-3q_6+24^\circ-1''t)$$

$$-(.00076-.0000000008''t)\cos(3q_5-3q_6-5''t-28^\circ.40')$$

$$+.00000104\cos(4q_5-3q_6+63^\circ)$$

The second of these quantities differs from that given by

MM. Pontecoulant and Laplace. The difference appears to arise from their having taken into account the eccentricity of only one of the planets.

These quantities, when substituted in the function relating to the mutual disturbance of Jupiter and Saturn, give for Jupiter

$$\delta\theta = 11.407'' \sin(3\phi_6 - 6\phi_5 + 2\phi_4 + 11^\circ.48'),$$

and for Saturn

$$\delta\theta = -(28.076 - .0043''t) \sin(3\phi_6 - 6\phi_5 - 2\phi_4 + 11^\circ.48'),$$

which latter, united with that arising from the direct perturbation of Uranus, gives for the entire inequality of Saturn

$$\delta\theta = -(40.035'' - .0067''t) \sin(3\phi_6 - 6\phi_5 + 2\phi_4 + 10^\circ.38 - 39''t).$$

Also there will be in the motion of Uranus the following inequality, whose period is nearly the same as that of the planet.

$$\delta\theta = -8.873'' \sin(2q_6 - 6q_5 + 2q_4 + 51^\circ.54');$$

and there will be in the motion of Saturn the term

$$\delta\theta = 1.28'' \sin(7q_5 - 2q_4 - 3q_6 - 59^\circ),$$

which arises from the perturbation of Uranus; and also the term

$$\delta\theta = -2.545'' \sin(2q_4 - 5q_5 + 3q_6 + 82^\circ\ 27'),$$

which arises from the perturbation of Jupiter.

Collecting, therefore, these results, we have

for Jupiter

$$\delta\theta = 11.407'' \sin(2\phi_4 - 6\phi_5 + 3\phi_6 + 11^\circ.48'),$$

and for Saturn

$$\delta\theta = 2.545'' \sin(5q_5 - 2q_4 - 3q_6 - 82^\circ.27')$$

$$+(40.035''-.0067''t)\sin(6\phi_5-2\phi_4-3\phi_6-10^\circ.38+39''t)$$

$$1.28''\sin(7q_5-2q_4-3q_6-59^\circ),$$

and for Uranus

$$\delta\theta=-8.873''\sin(2q_6-6q_5-2q_4+51^\circ.54')$$

$$+(43.371''-.0024''t)\sin(3\phi_6-6\phi_5-2\phi_4+7^\circ.52'-68''t)$$

Some other inequalities of the same kind will be given in a future number.

ART. II.—*On the Distribution of Heat over Islands, and especially over the British Isles.* Part I. By HENRY HENNESSY.

NO element among the conditions of terrestrial climate is so important, none has engaged so much attention, nor has any other been systematically observed for so long a period, as temperature: yet the time is comparatively recent when philosophers commenced to consider the laws of its distribution over the earth's surface in a truly scientific spirit. In 1779 appeared the mathematical inquiries of Lambert, in which an attempt was made to estimate the difference between the heat received by the earth from the sun and the heat which it loses by radiation. Mayer had about the same time deduced his well known law from theoretical grounds and by considering solar radiation alone as the source of terrestrial heat. Towards the close of the last century our countryman, Richard Kirwan, attempted for the first time to compare Mayer's law with existing observations, and thus to arrive at general views regarding the climate of our planet. Humboldt followed up this step by one of still more importance when he published his essay on Isothermal Lines. Laying aside speculative considerations, he presented the results of actual observation in a way at once novel and luminous. Having found the mean annual temperatures of a great number of stations, he compared them together and marked on a map the places which had equal temperatures. The points of equal tem-

perature having been joined by curves, the forms of the isothermal lines thus produced present a graphical picture of the distribution of heat over the earth. This elegant method of representation has since been applied to other elements of terrestrial physics, such as atmospheric pressure, magnetic intensity and declination, and the distribution of the tides.

While the science of terrestrial temperature was thus progressing by systematic induction from observed facts, some of its fundamental principles were examined and consolidated by the mathematical labours of Fourier, Poisson, and Laplace. Fourier, especially, has established with surpassing clearness the relations subsisting between the thermal conditions of the earth's surface, the warmth of its interior, and the temperature of the planetary spaces. His works also contain some highly suggestive views as to the influence of the physical properties of the superficial portions of the earth's crust on local and general climates.

To the meteorologist occupied in unravelling the records of numberless, complicated, apparently conflicting, observations, the researches of Fourier may furnish hope as well as light; for the beauty of his methods and the sublimity of their results give to his writings an indescribable charm, and his memory shines before the student like a star illuminating the true path of scientific discovery.

No one has more ably extended, or more effectively applied, Humboldt's graphical method of representing the distribution of terrestrial temperature than Professor Dove. Having tabulated a vast number of observations made in different parts of the world, he has not only been able to improve the representation of mean annual temperature, but has furnished us with maps of the isothermals of each month.[1]

A glance over the maps of mean annual, mean summer, mean winter, or mean monthly temperature, informs us of the general fact, that the temperature of a place depends on other circumstances besides its latitude. Mayer's law could not be true unless the isothermals were all parallel to the equator,—a relation which they are far from fulfilling. The same remark applies to the improved forms of Mayer's law, which have been subsequently suggested by different eminent scientific men.[2] Had the earth's surface been of uniform texture, and stripped of every kind of fluid

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[1] These maps appeared originally in the *Berlin Transactions*, but they are best known in these countries through the English edition prepared for the members of the British Association by General Sabine.

[2] Except a formula of Sir David Brewster's, in which he makes the mean temperature of a place depend upon its distance from two points of minimum

covering, the temperature of every point would depend upon its latitude, and places having the same latitude would possess the same temperature. But, three-fourths of the heat-absorbing and heat-radiating surface is water, and this, from its mobility and other properties, greatly modifies the distribution of the warmth which its particles receive from the sun. The surfaces of the seas and oceans are traversed by currents, whose temperatures influence the climate of any land which they approach, and whose directions depend on varied and complicated conditions. The resulting effect upon the temperature of the land must correspond in some measure to such complications.

But even if the ocean were free from currents, it might still influence the climate of the land, if it possessed a different mean temperature. That it does actually possess a higher mean temperature at its surface than the mean temperature of the air over the land, seems to have been definitely proved within a very recent period. The facts adduced by Admiral Duperrey, by which he was led to infer that the mean temperature of the liquid coating, which surrounds three-fourths of our planet, is higher than that of even the lower strata of its gaseous envelope, continue to receive additional confirmation in proportion to the number, sagacity, and activity of observers. Lieutenant Maury, whose labours have so greatly enlarged our knowledge of the physical conditions of the ocean, has especially contributed to establish the truth of the above conclusion. From whatever cause this superiority of oceanic temperature may arise, it imparts additional interest to the problem of the influence of the sea on the climate of the land.

This question has been already treated by Humboldt in his essay on the causes of the inflexions of isothermal lines;[3] but here I propose to examine it in a more general manner, and by following an order precisely the reverse of that which he has adopted.

In this way, I have succeeded in establishing a general law relating to the distribution of isothermal lines, which does not

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temperature, the one in Asia, the other in America. This was undoubtedly an improvement; but it did not justify the remark of an eminent writer, that the coördinates of latitude and longitude should be altogether discarded in connection with climate. The connection of the former is obvious, though complicated; the connection of the latter is less important, and it manifestly depends on the prevalent directions of oceanic and aerial currents, the influence of which on climate is universally acknowledged. See Forbes, Reports of the British Association, i. p. 215, second edition.

[3] "Fragments Asiatiques", ii. p. 397.

appear to have been previously noticed, and which comprehends as particular cases such as had been already observed.

Let us conceive an island situated in either hemisphere of the globe, and let it be completely surrounded with water possessing nearly the same temperature all around the coast. The temperature of any place on the island will depend upon constant and fluctuating causes. The former are the temperature of space, and the extremely small but steady flux of heat from the interior of the earth through its outer crust. The latter are the heat it directly gains from the sun, what it loses by radiation, what it receives from warm and loses from cold currents of the atmosphere, what it obtains by the condensation of moisture and gives back by evaporation.

The four last sources of gain and loss are manifestly connected with the conditions of the ocean in which the island is situated. If the surface of the ocean is warmer than the air over the island, the latter will gain in temperature by the interchange of currents of air over both. If we abstract all other causes, it is obvious that a point on the island would, in this case, be warmer, the closer it happened to be to the sea; in other words, its temperature would be a function of its distance from the coast. The isothermal lines of the island would be a series of nearly concentric curves having some relation in their shapes to the outline of the coast. If the influence of the amount of heat gained by sunshine above what is lost by radiation be now considered, it appears in general that the positions and shapes of the isothermals will be changed.

This change may be represented by transporting the centres of the isothermals towards the nearest pole of the earth.

For if H represent the effective amount of heat gained by a point in the island, its expression will be made up of two principal terms, of which the first, as we have just seen, must be a function of the distance c from the coast. The second would obviously be a function of the latitude λ, whether we take into account the absorption of the sun's rays in passing through the atmosphere or not. In the latter and more simple case $f(\lambda)$, can be found in terms of the latitude of the place, the sun's longitude, the inclination of the ecliptic to the equator, and the eccentricity of the earth's orbit. I have treated the problem of isothermal lines with the form of $f(\lambda)$ so found, and have arrived at the same conclusion as that which is here deduced, in a paper read before the Royal Irish Academy.

If we take into account the resistance of the atmosphere to the passage of sunshine through it, whatever knowledge we already possess shows that the loss of heat from this cause will increase with the obliquity of the sun's rays, and therefore it will be such a

function $\phi(\lambda)$, as to possess the property of increasing with λ, and its minimum value will be $\phi(0)$.

We may therefore write

$$H = F(c) + f(\lambda) - \phi(\lambda),$$

or simply,

$$H = F(c) + f(\lambda),$$

with the conditions that $F(c)$ continuously increases as c diminishes, down to $c=o$; and that $f(\lambda)$ continuously increases as λ diminishes, down to $\lambda=o$; so that the maximum value of H would be

$$F(o) + f(o).$$

If another point whose distance from the coast is c_1, and latitude λ_1, be situated on the same isothermal line, we must have,

$$H = F(c_1) + f(\lambda_1);$$

whence

$$F(c) - F(c_1) = f(\lambda_1) - f(\lambda).$$

It follows from the foregoing conditions that this equation cannot subsist unless we have the inequalities

$$\lambda < \lambda_1 \text{ and } c_1 < c, \text{ or}$$

$$\lambda > \lambda_1 \text{ and } c_1 > c.$$

Hence that part of the isothermal which has the greatest latitude must be nearer to the coast than any other part, and that which has the smallest latitude must be the most remote from the coast. Isothermals which had been previously near the coast would now no longer be closed curves, at least within the island, and thus several might terminate on the coast as irregular arcs, with their convex sides turned towards the equator. If the dimensions of the island in the direction of the meridian were very great, the isothermals might all terminate on the coast.

If predominating currents of wind should blow from any point of the compass, it is likewise evident that they will further influence the position of the isothermals in a manner that can be represented by shifting them away from, or by moving them towards, the point of the wind, according as it happens to be a warm or a cold current.

As the surfaces of islands are usually not flat, but covered with eminences and depressions, and as the temperature of any

point depends on its elevation above the sea, as well as on the other elements of its position, the transportation of the isothermals in an island would necessarily be accompanied by some change in their shapes, and thus, after transposition, they would not in general have the same detailed relations to the coast-line as in their concentric condition. As every piece of land, whether designated as a continent or as an island, is in reality surrounded by water, these views are capable of very general application. But, in the case of continents, as the oceans surrounding them do not possess the same temperature at different parts of their coasts, the function F (c) should receive different values for different places. In the case of islands of limited extent, we may, however, compare these views with observations without much difficulty.

It has been long recognized that the warm current, known to mariners as the Gulf Stream, bathes the shores of these islands as well as the greater part of the western coast of Europe. Very recently decisive evidence has been afforded of its calorific effects, not merely upon our western seaboards, but all around the entire coast-line of the British islands. They are thus situated precisely under such conditions as naturally lead us to expect to find the distribution of heat over their surfaces, such as would be indicated by groups of isothermal lines conforming to the law here adduced.

There are, in addition, some physical peculiarities in the structure of Ireland, which probably enhance the influence of the ocean upon the relative thermal conditions of its maritime and its inland portions. It is nearly surrounded at its coasts by ranges of mountains or lofty hills, and its interior consists chiefly of flat and low-lying plains. Eight such littoral ranges of elevated ground can be distinctly traced on a map of Ireland, each separated from its neighbour by some great outlet for the drainage waters of the interior. These elevated masses may be traced, 1. on the north-west coast in Donegal; 2. on the west in Mayo and Galway; 3. along the south-west coast in Kerry and Cork; 4. towards the south in Waterford; 5. on the east coast in Wicklow and Wexford; 6. on the north-east coast in Down; 7. towards the north-north-east in Antrim; and 8, near the north coast in Londonderry. The first of these groups trends principally from N.E. to S.W. The second from N. to S., with some nearly perpendicular offshoots. The fourth from E. to W.; the fifth from S.S.W. to N.N.E.; the sixth from S.W. to N.E.; the seventh is a rather irregular group of hills; the eighth trends from E. to W. It thus appears that the general direction of each of these groups is nearly parallel to the general direction of the adjoining coast. The only extensive line of coast which is not

backed by a hilly or mountain barrier is that lying between the Wicklow and Mourne mountains.

Although it would be difficult to estimate the precise influence of these elevated masses in obstructing interchanges between the air surrounding the coast and that of the interior, they doubtlessly must produce some effect. It is at least obvious that moist and warm currents, encountering such masses, would lose with a portion of their moisture some of their heat, and would, on reaching the inland plains, be observed by the inhabitants colder as well as drier than the same winds had been noticed by those residing on the coast.

The considerable opening from the interior towards the sea, which has been just referred to, happens to be situated in the direction of those winds which blow least frequently in Ireland, and which, at the same time, possess the least moisture and warmth.

Although observations on temperature have hitherto been made at very few stations in Ireland, it is still possible to compare what has been done with the principles here put forward. During the year 1851, a series of meteorological observations were conducted under the management of a committee of the Royal Irish Academy, and the stations, although not numerous, were fortunately so distributed as to enable us to combine their results in such a way as to clearly illustrate the thermal conditions of the island. The most important results are contained in the Rev. Dr. Lloyd's valuable memoir on the Meteorology of Ireland.[4]

As to temperature, the observations had a two-fold application; 1st, those referring to the temperature of the sea, and 2ndly, those relating to the temperature of the air. A comparison of both classes of observations establishes the fact of an excess of temperature of the sea over the air in 1851, amounting to 3° 8 Fahrenheit. The mean temperature at Portrush, the most northern station, during the same year, was 49.1, and that at Castletownsend, the most southern, 52.1. The excess of temperature of the sea over that of the air appears thus greater than the greatest difference of temperature which could arise between two stations as a consequence of their difference of latitude

On comparing the mean annual temperatures of the sixteen stations where observations were made in 1851, I immediately saw that the following approximately isothermal groups could be formed.

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[4] Trans. Royal Irish Academy, vol. xxii. p. 411.

Mean Temperature of Isothermal Group.	Station.	Temperature.	Diff. from Isothermal.	Remarks.
°		°	°	
48·4	Armagh, .	48.6	+0.2	Inland Stations.
	Markree, .	48·2	–0.2	
	Athy, . .	48·4	0.0	
49·05	Portrush, .	49.1	+0.05	North Coast.
	Buncrana, .	49.0	–0.05	
50.26	Killough, .	50.2	–0 06	East and N.E. Coast.
	Dublin, .	50.3	+0.04	
	Courtown, .	50.3	+0.04	
50.85	Kilrush, .	50.9	+0.05	Estuary of the Shannon.
	Killybegs, .	50.8	–0.05	Donegal.
51.45	Dunmore, .	51.5	+0.05	Co. Waterford.
	Westport, .	51.4	–0.05	Mayo.
52.2	Cahirciveen, .	52.1	–0.1	S.S.W. Coast.
	Castletownsend	52.3	+0.1	

The remaining two stations, Donaghadee and Portarlington, could not be included in any of these groups, as their temperatures were respectively 49°.6 and 47°.3.

Before I had made these combinations, Dr. Lloyd had remarked the singular difference between the temperature of the inland stations and those on the coast. In the small map which accompanies his memoir, the isothermal lines are deduced from the coast observations alone; and the author thus seems to indicate that these lines are intended to show the isothermals of the air over the sea surrounding Ireland, but not the distribution of temperature within the island itself. From the comparatively regular forms of such lines on the surface of the ocean, Dr. Lloyd assumed that over a small space they might be regarded as approximately straight; and he was thus enabled to apply the method of least squares for the precise determination of their positions.

As I could not assume any definite form for the interior isothermals, I could not use the method of least squares, and

have had to lay them down by the ordinary method of tracing curve lines, each of which runs through a group of stations of equal temperature. On looking at the map, it is apparent that, having first traced the isothermal of Cahirciveen and Castletownsend, the isothermal of the next lowest temperature must fall completely inside it, for otherwise it would not be an isothermal line. But this line runs through Westport and Dunmore, and is therefore much longer. The line which represents the next lowest temperature is included within this; thus we have four open isothermals, until we come to the isothermal of Portrush and Buncrana. But as this must be included within the preceding, it would, if produced at each extremity, form a reëntrant curve. The isothermal of Armagh, Markree, and Athy, must be included within that of Portrush and Buncrana; and thus we have a second closed isothermal. But the station of least temperature, Portarlington, must be situated within this, and it actually does lie nearly between Markree and Athy, although much nearer to the latter. Any other places possessing the same mean temperature as Portarlington, must be situated within the isothermal of Armagh, and if such a line pass through Portarlington, it must also be reëntrant.

Donaghadee, as should be expected, lies inside the prolongation of the isothermal of Dublin, Courtown, and Killough, and outside the isothermal of Portrush and Buncrana.

All these results completely harmonize with the views I have put forward, and I feel perfectly assured that further observations will only confirm the truth of my general conclusions. In Ireland we thus perceive that the coldest district lies in the north-east portion of the midland counties—probably somewhere between the counties of Cavan and Tyrone, and that the warmest region is situated along the coasts of Kerry and Cork.

Dr. Lloyd has deduced a result of some interest in connection with medical climatology, namely, that if a high winter temperature and a small diurnal range of the thermometer are favourable conditions of climate for the residence of invalids affected with pulmonary complaints, Cahirciveen is the locality which, in Ireland, appears to possess these advantages in the highest degree. But it appears that at all the coast stations the diurnal range of the thermometer is very small, and it will be hereafter seen that the approximate parallelism of the isothermal lines to the coast is more decided during the winter months than at any other period of the year. A person suffering from the maladies referred to would thus probably derive equal benefit from the climate at any part of the south-western coast between the mouths of the Shannon and Blackwater, and he would thus be in a better position

for selecting a place of residence that might combine in the highest degree all the other requirements which, as well as climatological advantages, might assist in promoting his health.

I now proceed to examine how far the distribution of heat over the island of Great Britain conforms to the general laws that have been shown to regulate it in Ireland. Here there are some remarkable conditions in the physical configuration of the island which should be kept in view in considering its thermal conditions. The western coast alone is backed by any considerable masses of elevated land, and the interior is generally far from being so flat as the inland portions of Ireland. Its position with regard to the warmer and more prevailing winds, as well as the magnitude of the Bristol Channel, indicates that this great arm of the sea may exercise a remarkable influence on districts in the valley of the Severn which might otherwise possess a climate similar to places more strictly inland. Lastly, the much greater length of the island in the direction of the meridians, compared to its mean breadth in the direction of the parallels, would seem to point to a very different distribution of temperature from that which exists in Ireland.

The observations on the temperature of the sea recorded in Dr. Lloyd's memoir show that, in the Irish Sea and St. George's Channel, as well as in the Atlantic Ocean, the mean temperature of the surface-water exceeds that of the air. A similar result has been found by observations made on the surface of the German Ocean at Scarborough, although the excess of the water temperature above that of the atmosphere in this case is not so remarkable as in the former. It is to be hoped that Captain Woodall, who announced this interesting fact at the meeting of the British Association held in 1856 at Cheltenham, will publish the observations which have led him to a result so important.

As it thus appears to be placed beyond the possibility of reasonable doubt, that the shores of Great Britain, like those of Ireland, are washed by heat-bearing currents, I was prepared, notwithstanding the diversity of configuration of the two islands, to find some approach towards the reëntrant shape in the isothermals of the former. In order to construct these lines, I have made use of the valuable tables calculated by Professor Dove and printed in the Report of the British Association for 1847, and of the quarterly returns of the state of the weather in England, published by Mr. Glaisher. I have also availed myself of some detached results which are not contained in either of these collections. In Mr. Glaisher's returns will be found the names of the observers to whose patience and devotion to science we owe many of these interesting facts.

Having calculated the mean annual temperatures for more than fifty places not already in Dove's table, and corrected a few of his results by the aid of subsequent observations, I combined them in approximately isothermal groups, precisely as I had already done in the case of Ireland. The isothermal lines laid down in the map which accompanies this essay, have been drawn by the aid of such indications, most weight being attached to the results of the best observations. These lines are not intended to represent with perfect accuracy the mean annual distribution of temperature, because in some extensive districts observations are entirely wanting, although made in great numbers in certain localities. Although these isothermals may thus require some ulterior modifications, I have no reason to doubt their faithfulness in presenting a general view of the distribution of temperature. The influence of distance from the coast, as well as of latitude, is very distinctly visible, and the arrangement of the isothermals evidently conforms to the same laws as those of Ireland.

The mean temperatures of stations where observations have been made, have been recorded usually in connection with certain coördinates of each station, namely, its latitude, longitude, and elevation above the level of the sea.

While the influence of latitude and longitude is now more justly estimated, that of elevation above the sea is sometimes liable to be overrated. The decrease of temperature with height has generally been calculated from observations made on the sides and summits of mountains, or by comparison of the thermal conditions of successively overlying portions of the atmosphere during the voyages of balloons. But a much slower rate of decrease must take place in the temperature of the air which touches gradually rising and widely spread surfaces, than along nearly vertical lines or rapidly ascending planes. The manner in which the air becomes heated by contact with the ground is sufficient to indicate the truth of this conclusion. Thus, although some of the best determinations from observations made in balloons give a decrease of 1° Fahr. for 276 feet, the decrease of temperature on the sides of mountains has been estimated at 1° in 355 feet, and at 1° in 433 feet on the surfaces of elevated plains.[5]

The mean elevation of the greater number even of the inland stations of Great Britain whose temperature has been determined, is probably less than 200 feet, and almost all such stations are situated on gently undulating or low lying grounds. The highest

[5] 195 metres and 235 metres for 1° C. Kæmtz Meteorologie, p. 215, French edition.

station in Ireland is only 230 feet above the level of the sea, and it is situated in the great central plain of the island.

As the heights of most of the inland and coast stations in Ireland have been determined with more than ordinary care by actual levelling, we may estimate with remarkable precision the elevation corresponding to a decrease of temperature of one degree, on the supposition that vertical height above the sea, and not horizontal distance from its surface, produces the low temperature of the interior as compared with that of the regions bordering on the coast. For this purpose we should manifestly compare a group of inland with a group of coast stations nearly on the same parallel of latitude. The following are thus selected from the table of mean annual temperature of Ireland:—

INLAND STATIONS.

	Latitude.	Temperature.	Elevation in feet.
Armagh	54°21′	47°.8	211
Markree	54 12	47 .8	132
Portarlington	53 9	47 .0	230
Limerick	52 40	49 .4	92
Means	53 35	48.0	166

COAST STATIONS.

Killybegs	54°34′	50°.5	20
Killough	54 13	49 .9	23
Dublin	53 21	50 .0	19
Kilrush	52 38	50 .8	45
Means	53 41	50.3	27

The mean latitude of the coast stations is 6′ greater than that of the inland stations, and is thus slightly unfavourable to an excess of temperature; yet the mean temperature of the former exceeds that of the latter by 2°.3. The mean difference in height is 139 feet; consequently, if the greater warmth of the coast were due to difference of elevation alone, the rate of decrease of atmospheric temperature in ascending over ground lying at an almost insensible mean inclination to the horizon, would be 1° for 60 feet. A supposition which leads to a result so discordant with the best observations must be abandoned as altogether untenable.

Hitherto, distance from the sea has but rarely entered into temperature tables, and then only for a limited number of stations. It now appears to possess claims to be definitively considered as a fourth coördinate, and in the case of most of the

stations in the British islands it is undoubtedly the most important after latitude. In the accompanying tables a column has been accordingly appended, in which the value of this element is given in English miles. The distances are all taken from the maps published by the Society for the Diffusion of Useful Knowledge. When a distance is taken from the mouth of a river or estuary, it is generally not counted from the nearest point of the coast, but from some point about midway between the opposite shores of the inlet.

The mean temperatures, marked D, are taken from Dove's Table; those marked *n*, I have calculated entirely from other sources; those unmarked are combinations of such results together with those contained in Professor Dove's tables. In the table which exhibits the mean annual temperature of twenty-three stations in Ireland, the results marked L are given on Dr. Lloyd's authority. He estimated these numbers from the observations of 1851, by subtracting 0°.3 from each, because in Dublin the temperature of the year was in excess of the mean of twelve years by that quantity. The mean temperatures so deduced are probably much closer to their true values than the uncorrected results of 1851. This may be noticed with reference to stations where observations were made during other years, such as Armagh and Markree, where the temperature is regularly recorded at the astronomical observatories of Dr. Robinson and Mr. Cooper.

The observations at Cove were made by Dr. Scott; at Cork, by Mr. Humphreys and his predecessors at the Royal Institution, also at the barracks; at Limerick and Kilrush, in connection with the Ordnance Survey; at Derry, by Mr. Patterson; at Waterford, by Dr. Cavet;[6] at Belfast, under the superintendence of Professor Stevelly at the college.

The isothermals of the northern portions of the two great continents which constitute the old and new worlds, exhibit, at least during the winter, very decided conformity to the same laws as those which are so manifest in the British isles.

On examining Professor Dove's large map of the isothermals of January and July (No. 3 in General Sabine's edition), it appears that during the former month the isothermals which traverse North America run very nearly parallel to its western coast; then bending, they run nearly parallel to the northern shores of the Gulf of Mexico; afterwards they ascend towards the north-east, and cut the eastern coast of the United States, Canada, and Labrador at very oblique inclinations. In Europe, those

[6] Wilde in the Reports of the Census Commissioners. Tables of Deaths, vol. i.

which approach the sea appear in general to be parallel to the coast, as in Scandinavia and on the western and southern coasts of France. In Asia, some of the isothermals approach in shape a rude outline of that great division of our continent, and many appear to cut the northern coast of Siberia almost at right angles to the parallels of latitude, precisely in the same manner as some of those in the British islands, which are not reëntrant curves.

These results indicate the existence of the two poles of minimum temperature suggested by Sir David Brewster,[7] but a more general conclusion may be drawn from the entire of the preceding reflections, namely, that there are nearly as many poles of minimum temperature upon the globe as there are islands and continents distributed over its surface.

Table of the Mean Annual Temperature of Great Britain.[8]

	Station.	No. of years	Mean Annual Temperature.	Latitude, north.	Longitude, west.	Elevation above the sea	Distance from sea	Sea from which the distance is counted.
			°	° ′	° ′	Feet	Miles	
D	Calenik	5	53.0	50 0	5 10	...	0	British Channel, south coast of Cornwall.
n	Ventnor (I. of Wight)	6	52.2	50 36	1 13	...	0	
	Helston	13	52.1	50 9	5 18	...	1	
D	Sidmouth	3	52.1	50 41	3 13	...	0	British Channel.
	Plymouth	7	52.0	50 22	4 7	75	0	
D	Penzance	21	51.8	50 7	5 33	...	0	
D	Gosport	16	51.8	50 47	1 7	...	0	
	Falmouth	9	51.6	50 9	5 6	...	2	British Channel.
D	Southwick	11	51.5?	52 30	-1 25	...	10	German Ocean.
	Swansea	6	51.2	51 36	3 53	...	0	St. George's Channel
n	Maidstone	2	51.2	51 16	-0 33	80	16	
n	Torquay	6	51.0	50 25	3 30	...	0	British Channel
n	Uckfield	2	50.9	50 58	0 5	180	14	
n	Gloucester	1	50.9	51 52	2 14	...	27	Bristol Channel.
	Truro	7	50.8	50 16	5 3	43	7	British Channel.
	Bristol	2	50.7	51 27	2 36	...	9	Bristol Channel.
n	Ryde (I. of Wight)	6	50.7	50 43	1 11	...	0	British Channel.
M	Lyme Regis	13	50.7	50 43	2 56	...	0	British Channel.
	Liverpool	28	50.6	53 25	2 59	...	0	Liverpool Bay.
	London	61	50.5	51 30	0 5	...	38	Mouth of Thames.

[7] See note 2.

[8] The temperatures are given in degrees of Fahrenheit's scale. The longitudes are counted from the meridian of Greenwich; those with the sign - prefixed are east, and those without any sign are west.

	Station.	No. of years	Mean Annual Temperature.	Latitude, North.		Longitude, West.		Elevation above the sea	Distance from sea.	Sea from which the distance is counted.
			°	°	′	°	′	Feet.	Miles	
n	Hastings	2	50.2	50	53	−0	35	...	0	British Channel.
n	Teignmouth	4	50.1	50	33	3	55	...	0	British Channel.
n	Pencarrow	4	50.0	50	20	4	53	230	10½	British Channel.
n	Exeter	12	50.0	50	44	3	21	164	9	British Channel.
	Douglas (I. of Man)	11	50.0	54	12	4	30	...	0	Irish Sea.
D	Chiswick	16	49.9	51	29	0	18	...	42	Mouth of Thames.
n	Southampton	5	49.8	50	54	1	24	...	9	British Channel, mouth of Southampton Water.
	Cheltenham	16	49.8	51	54	2	4	...	34	Bristol Channel.
n	Newport (I. of Wight)	5	49.5	50	42	1	19	...	4	British Channel, mouth of Southampton Water.
	Chichester	5	49.5	50	52	0	45	...	5	British Channel.
n	Lewisham	6	49.5	51	26	0	2	...	34	British Channel.
D	Cobham	1	49.5	51	20	0	23	...	36	British Channel.
D	Bushey Heath	8½	49.3	51	38	0	22	...	50	Mouth of Thames
D	Tottenham	25	49.2	51	36	0	5	...	32	Mouth of Thames
D	Bolton	10	49.1	53	35	2	24	..	25	Mouth of the Ribble.
n	Worthing	6	49.0	50	48	0	22	...	0	British Channel.
	Greenwich	10	49.0	51	29	0	0	156	33	Mouth of Thames.
n	Worcester	3	49.0	52	12	2	13	125	50	Bristol Channel.
	Boston	21	49.0	52	48	0	5	...	7	The Wash beyond the Shallows.
	Whitehaven	16	49.0	54	33	3	33	...	0	The Irish Sea.
n	Hull	10	49.0	53	35	0	20	...	12	Mouth of the Humber.
n	Bicester	5	48.9	51	52	1	10	...	72	Bristol Channel.
D	Crumpsal	8	48.8	53	32	2	14	66	35	Irish Sea, at the mouth of the Ribble.
n	Keyingham		48.8	53	33	0	5	...	7	Mouth of the Humber.
	Manchester	49	48.8	53	29	2	14	...	32	Liverpool Bay.
n	Enfield	5	48.7	51	41	0	5	...	39	Mouth of the Thames.
n	Hartwell	7	48.7	51	49	0	50	...	70	Mouth of the Southampton Water.
n	Bedford	7	48.7	52	8	0	30	...	64	German Ocean.
D	Lyndon	28	48.7	52	32	−0	3	510	32	German Ocean.
n	Royston	6	48.6	52	3	0	1	...	47	Mouth of the Blackwater, in the German Ocean.
D	St. Andrew's	8	48.6	56	21	2	48	70	0	Mouth of Frith of Forth, German Ocean.
n	Oxford	9	48.5	51	46	1	16	...	65	British Channel, at Southampton Water.
	Aberdeen	10	48.4	57	9	2	5	50	0	German Ocean.
D	Leith	2	48.4	55	59	3	10	..	0	Frith of Forth.
D	Hawkshill	3	48.4	55	58	3	10	...	0	Frith of Forth.

	Station.	No. of years	Mean Annual Temperature.	Latitude, North.		Longitude, West.		Elevation above the sea	Distance from sea.	Sea from which the distance is counted.
			°	°	′	°	′	Feet.	Miles	
n	Thame	1	4.83	51	45	0	58	...	68	British Channel, at Southampton Water.
n	Cardington (near Bedford)	7	48.3	52	8	0	30	...	64	German Ocean.
n	Norwich	7	48.3	52	37	–1	18	32	17	German Ocean.
n	Lampeter	3	48.2	52	8	4	4	420	12	Cardigan Bay; hills intervening
n	Bywell	2	48.2	54	57	1	54	...	20	German Ocean.
	Bute		48.2	55	48	5	2	...	2	Frith of Clyde.
n	Rosehill (near Oxford)	7	48.1	51	46	1	16	270	65	British Channel, at Southampton Water.
n	Hartwell Rectory	6	48.1	51	49	0	51	...	70	Mouth of Southampton Water.
D	Ackworth	18	48.1	53	39	1	20	...	52	German Ocean.
D	Anatomical Gardens [St. Andrew's?]	7	48.0	56	24	2	48	...	0	German Ocean.
n	Holkham	7	48.0	52	57	–0	46	...	2	German Ocean.
n	Hawarden	7	48.0	53	10	3	1	260	15	Mouth of the Dee.
n	Grantham	7	47.9	52	55	0	38	...	30	German Ocean.
	York	10½	47.9	53	57	1	5	...	27	German Ocean.
n	Berkhampstead	3	47.8	51	45	0	35	..	61	Mouth of the Thames.
n	Linslade (north of Aylesbury)	4	47.8	51	50	0	45	...	68	Mouth of the Thames
n	Nottingham	7	47.8	52	56	1	14	181	60	German Ocean.
n	Wakefield	7	47.8	53	41	1	29	...	59	German Ocean.
D	Malvern	1	47.7	52	7	2	19	...	40	Bristol Channel.
n	Newcastle	1	47.7	54	58	1	36	...	9	German Ocean.
n	Eign (Hereford)	1	47.6	52	3	2	42	...	34	Bristol Channel.
n	Alderley Edge	1	47.6	53	17	2	17	...	34	Liverpool Bay.
D	New Malton	8½	47.6	54	8	0	47	85	18	German Ocean.
n	Clifton	5	47.5	51	7	2	26	?	8	Bristol Channel.
n	Gainsborough	5	47.5	53	24	0	47	...	34	German Ocean.
D	Colinton	5	47.4	55	55	3	16	364	5½	Frith of Forth.
D	Clunie	16	47.3	57	12	2	35	...	20	Solway Frith.
D	Keswick	4¾	47.3	54	33	3	9	240	18	Irish Sea; mountains intervening.
n	Glasgow	3	47.3	55	51	4	14	...	25	Frith of Clyde.
	Derby	9	47.2	52	58	1	30	160	68	German Ocean, near the Wash.
	Edinburgh	18	47.2	55	58	3	11	...	2	Frith of Forth.
n	Scarborough	3	47.1	54	17	0	23	?	0	German Ocean.
n	Warrington	3	47.0	53	24	2	36	...	17	Liverpool Bay.
D	Kendal	13	47.0	54	17	2	46	130	13	Morecambe Bay.
	Elgin	4	47.0	57	38	3	16	...	4	North Sea.
D	Carlisle	24	47.0	54	54	2	58	...	16	Irish Sea.
D	Wick	2	46.9	58	29	3	5	...	1	North Sea.

	Station.	No. of years	Mean Annual Temperature.	Latitude, North.		Longitude, West.		Elevation above the sea	Distance from sea.	Sea from which the distance is counted.
			°	°	′	°	′	Feet.	Miles	
D	Knutsford	10	46.9	53	20	2	20	...	26	Liverpool Bay.
D	Kinfaun's Castle	22	46.9	56	23	3	19	140	22	German Ocean.
n	Belvoir Castle	3	46.8	52	45	–0	24	...	15	German Ocean, at the Wash.
D	Carbeth	4	46.8	56	0	4	22	480	26	Frith of Clyde.
n	Knebworth	3	46.7	51	49	0	13	...	51	Mouth of the Thames.
D	Lancaster	7	46.4	54	3	2	48	...	6	Morecambe Bay.
n	Durham	3	46.4	54	46	1	37	352	10	German Ocean.
n	Stonyhurst	7	46.3	53	52	2	23	...	22	Morecambe Bay.
n	Dunino	4	46.3	56	16	2	49	250	4	German Ocean.
D	Sandwick (Orkney)	$5\frac{1}{2}$	46.2	59	5	3	17	100	0	Atlantic Ocean.
n	Allenheads	2	46.2	54	49	2	16	...	46	Solway Frith.
	Makerstoun	$2\frac{2}{3}$	46.1	55	35	2	31	211	26	German Ocean.
n	North Shields	6	46.0	55	0	1	25	...	1	German Ocean.
n	Inverness	2	45.8	57	30	4	12	...	13	Moray Frith.
n	Anstruther	1	45.7	56	15	2	41	...	0	German Ocean.
D	Applegarth	19	45.6	55	13	3	12	170	12	Solway Frith.
D	High Wycombe	4	45.5	51	36	0	35	?	60	English Channel.
n	Arbroath	4	45.5	56	34	2	34	...	0	German Ocean.
D	Dunfermline	20	45.2	56	5	3	26	...	4	Frith of Forth.
D	Alford	10	45.1	57	13	2	45	420	28	German Ocean.
n	Laurencekirk	1	44.6	56	50	2	30	140	$5\frac{1}{2}$	German Ocean.
D	Bonally	5	44.2	55	56	3	16	1100	6	Frith of Forth
D	Leadhills	10	44.1	55	25	3	48	1280	33	Irish Channel.
D	St. Bathans	1	43.9	55	52	2	23	420	$6\frac{1}{2}$	German Ocean.
n	Kingussie	1	42.8	57	4	4	5	750	40	Moray Frith.

Table of the Mean Annual Temperature of Ireland.

	Station.	No. of years	Mean Annual Temperature.	Latitude, North.		Longitude, West.		Elevation above the sea	Distance from sea.	Sea from which the distance is counted.
			°	°	′	°	′	Feet.	Miles	
L	Caherciveen	1	52.0	51	56	10	13	52	2	Atlantic Ocean.
L	Castletownsend	1	51.8	51	33	9	9	18	2	Atlantic Ocean.
	Cove (Queenstown)	15	51.5	51	50	8	19	...	4	St George's Channel
	Cork[9]	30	51.5	51	54	8	29	28	12	St George's Channel
L	Westport	1	51.4	53	50	9	37	17	2	The Atlantic at Clew Bay.

[9] The observations of every kind made at Cork embraced probably a longer period.

	Station.	No. of years	Mean Annual Temperature.	Latitude, North.	Longitude, West.	Elevation above the sea	Distance from sea.	Sea from which the distance is counted.
			°	° ′	° ′	Feet.	Miles	
L	Dunmore	1	51.3	52 8	6 59	66	0	St George's Channel
	Kilrush	$2\frac{2}{3}$	50.8	52 38	9 30	45	10	Mouth of the Shannon.
L	Killybegs	1	50.5	54 34	8 27	20	0	Atlantic Ocean.
L	Courtown	1	50.0	52 39	6 13	34	0	St George's Channel
L	Dublin	12	50.0	53 21	6 15	19	3	Irish Sea.
L	Killough	1	49.9	54 13	5 40	23	0	Irish Sea.
	Limerick	3	49.4	52 40	8 38	92	37	Mouth of the Shannon.
L	Donaghadee	1	49.3	54 38	5 33	16	0	Irish Sea.
	Derry	1	48.9	55 0	7 20	...	14	Mouth of Lough Foyle.
L	Portrush	1	48.8	55 13	6 41	29	0	Atlantic Ocean.
L	Buncrana	1	48.7	55 8	7 27	48	4	Mouth of Lough Swilly.
	Waterford	3	48.6	52 15	7 10	?	9	St George's Channel
	Belfast	6	48.6	54 37	5 57	...	10	Mouth of Belfast Lough
L	Athy	1	48.1	53 0	6 58	200	35	St George's Channel
	Armagh	14	47.8	54 21	6 39	211	30	Irish Sea
	Antrim		47.8	54 43	6 8	...	20	Irish Sea.
	Markree	14	47.8	54 14	8 28	132	18	Mouth of Sligo Bay.
L	Portarlington	1	47.0	53 9	7 12	230	45	Irish Sea.

ART. III.—*On the presence of Ammonia and Nitric Acid in the Sap of Plants.* By WILLIAM K. SULLIVAN.

Azotic bodies constructed on ammonia type.

THE discovery of the compound ammonias, and the classification of bodies by homologous series, having thrown considerable light upon the class of bodies termed amides, an ingenious view has been suggested as an extension of that of M. Gerhardt's,—that we may regard most quaternary organic bodies containing nitrogen, whether neutral acid or basic as constructed on the type of ammonia, that is, of one or several molecules of ammonia, in which the single hydrogen molecules are replaced by binary or ternary compound ones. A considerable number of amides can be produced by reactions, which are certainly better explained upon this view than by any other; but there are

Many amides best explained

In this way, but the albuminous bodies not yet referable to it.

many natural constituents of plants containing nitrogen, which, although connected by analogies with the amides just mentioned, we would scarcely be justified in referring to the ammonia type in the present state of our knowledge regarding them—we are indeed almost wholly ignorant of the true composition of most of them, and cannot reproduce any of them artificially. In this group of comparatively unknown and unclassed compounds is included a remarkable class of substances, found universally in plants and forming the greater part of animals, and which, to avoid perpetuating the nomenclature of a theory now generally considered inadmissible, may be distinguished as the albuminous bodies. The phenomena of growth may be said to almost consist in the production and transformation of those bodies. Hence, the discovery of their true composition is almost synonymous with that of the chemical phenomena accompanying growth.

Knowledge of their constitution synonymous with chemistry of growth.

Plants receive all their nitrogen as ammonia and nitric acid.

Whatever may be the final result of the inquiries as to whether plants possess the power of assimilating nitrogen directly from the atmosphere, there can be no doubt that practically plants receive all their nitrogen in a state of combination—chiefly with hydrogen as ammonia, but also with oxygen as nitric acid. Probably in every case ammonia is the starting point of the successive agglomeration of molecules which ends in the production of the albuminous bodies, a circumstance which would, if established, confirm the view that they were constructed upon the ammonia type. It would also appear that glucose, or rather perhaps the whole class of bodies, which, for convenience sake, we might call hydrates of carbon, performs some prominent part in this ascending series of transformations.

Ammonia the probable starting point.

Function of glucose.

This view supported by products of decomposition of albuminous bodies.

The products of decomposition of the albuminous bodies appear to lend considerable support to this view. Thus, when they undergo spontaneous decomposition, several acids of the series homologous with acetic acid, leucine, tyrosine, ammonia, and as I have recently shown,[1] trimethylamine, ethylamine, etc., are formed. Heated with fused hydrate of potash, they yield the same acids, leucine, tyrosine, ammonia (traces of compound ammonias are always found in the disengaged

[1] Hesse, it appears, has also obtained similar results—see an account of his experiments among the *Scientific Notices*.

ammonia), and hydrogen. Distilled with sulphuric acid and deutoxide of manganese, they yield the same homologous acids and their hydurets, and also the hyduret of benzoyle; with the more energetic oxidizing mixture of sulphuric acid and bichromate of potash, the products are nearly the same, but there is also formed hydrocyanic acid and valeronitryle, or cyanide of tetryle, a body resulting from the action of hydrocyanic acid upon hyduret of valeryle.

But ammonia is not only absorbed by the roots of plants, but also sometimes exhaled by the flowers or leaves, as Chevallier, I believe, first pointed out in the case of Chenopodium Vulvaria; and Dessaignes has since shown that propylamine (or more probably the isomeric base, trimethylamine) accompanies the ammonia. This remarkable circumstance appears to indicate that, either a portion of the nitrogenous compounds formed from the absorbed ammonia is again decomposed, and the ammonia set free during the process of growth, or that ammonia performs other functions besides contributing to the formation of albuminous bodies. The first view seems to harmonize with the change which albuminous bodies undergo in passing into those active states in which they exert so remarkable an action upon starch, etc. It is very probable that the action of such ferments as diastase is sometimes accompanied by the production of ammonia, compound ammonias, small quantities of the acids homologous with acetic acid, and carbonic acid —that is, that the action may be considered as a kind of putrefaction. Traces of ammonia and of the acids in question are invariably found in the ordinary fermented liquors, especially when the process is carried very far. There are also many reasons for supposing that this is really the case during the germination of seeds having an endosperm.

Ammonia also exhaled by flowers, etc.

Azotic bodies decomposed during growth evolve ammonia.

Action of diastase analogous to putrefaction.

Ammonia, etc., formed by fermentation.

The nitrogen of active substances may not always be separated in these transformations as ammonia: it is quite possible that in some plants it may be separated in an uncombined condition. Saussure, indeed, showed that plants evolved nitrogen as well as oxygen when exposed to sunlight. Some, as Boussingault, consider that the nitrogen thus evolved is derived from that contained in the water absorbed by the roots, but Draper concludes from his experiments, that it is derived from an azotized substance acting as a ferment. Or it may be separated as

Nitrogen of active bodies evolved.

Experiments of Saussure, Boussingault, Draper.

It may be separated as a fixed base, a fixed base, and may be deposited in the bark or seeds, and again take part in further transformations. It certainly does appear as if several of the organic bases found in plants should be considered merely as excretions.

supported by ammonia found in barks. This view seems to be supported by the interesting circumstance that ammonia appears to always accompany vegetable alkalies in barks. Thus Reichardt[2] found 0.137 of ammonia (calculated as NH_4O) in the dried cinchona bark of *Calysaya plana*, 0.123 in that of *Calysaya convoluta*, 0.086 in young weak pieces of Huanco cinchona 0.100 in the bark of *Cinchona ovata*, var. *erythroderma* (Wedell), and in a specimen of bark from *Cinchona cordifolia*, 0.266, or more than one-fourth of the whole organic bases present. Reichel[3] found in old strong pieces of Huanco bark, 0.070 of ammonia (NH_3), and in the bark of the stem of *Cinchona Condaminea*, var. *lancifolia*, 0.210, or nearly one-third of the whole amount of quinine cinchonine and quinidine found in the same specimen; in the bark of the stems of the same species, he found 0.220, and in that of the twigs, 0.153 per cent.

Nitric acid may be formed in plants, There is one other form of combination in which the nitrogen may possibly present itself when it has fulfilled the functions of a ferment in plants, namely as nitric acid. I mention this singular hypothesis merely for the purpose of suggesting a line of research which cannot fail to lead to many important results, whatever may become of the hypothesis itself. To anticipate the results, which I am about to give presently, I may observe that nitrates occur in small quantities very generally in the sap of most plants, but in those plants especially which either perceptibly evolve ammonia, or which yield it along with compound ammonias when distilled with water. supported by distribution of nitrates in some plants. In such cases the nitrates are more abundant in the leaves and leaf-stalk, and in bulbous-rooted plants in the crown from which the leaves spring. The proportion of nitric acid is often so considerable in the leaves that it is difficult to suppose it wholly derived from nitrates absorbed by the roots from the soil. This difficulty appears to be increased by the circumstance that in bulbous roots, at least in those which I examined, the parts nearest the

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[2] Chemisch-physiologische Abhandlung über die Chemischen Bestandtheile der Chinarinden von Dr. E. Reichardt. Braunschweig, 1855; also Gmelin's Handbuch, Bd. viii. S. 51 & 52.

[3] Ueber Chinarinden und deren Chemische Bestandtheile. Leipzig, 1856; also Gmelin's Handbuch, Bd. viii. S. 52 & 53.

fine rootlets do not contain more nitrates than the centre, but on the contrary less, and that they appear to spread downwards from the leaves. The following results show this distribution of the nitric acid in an entire plant of sugar beet weighing about 8 lbs.:—

	Per-centage of nitric acid.
1. The whole of the leaves and leaf-stalk, . . .	0.180
2. Upper segment of crown, ...	0.220
3. Segment of bulb ½ inch thick, cut at right angles to axis one inch below crown, ...	0.060
4. Similar segment cut 2½ inches below No. 2, . .	0.040
5. Similar segment cut 3 inches below No. 3, or a little below the middle zone of root, ...	0.045
6. Point of root 2½ inches long, ...	0.020

This distribution of nitrates corresponds exactly with that already pointed out for the solid matter. It is possible that some of the ammonia liberated in the leaves or existing in the sap may have been oxidized by the nascent oxygen set free in the leaves by the action of sunlight, and may thus account for the accumulation of nitrates in the leaves and crown. This nitric acid would of course be gradually removed from the leaves and again decomposed. It may of course be objected, that the nitrates absorbed from the soil accumulated in the leaves very much as other saline matter. This might no doubt explain it; but then, on the other hand, when beet is grown on land heavily manured with nitrates, they are absorbed and are found in every part of the plant, but in such excess in the bulb as sometimes to replace nearly the whole of the sugar; the accumulation in the leaves not being in a corresponding proportion. I am fully sensible that experiments such as those just given are not of that definite character which should be adduced in support of so novel an hypothesis. I did intend to make a series of experiments with plants of tobacco, different species of chenopodium, etc., so soon as I could get an opportunity; but in the meanwhile it may be worth while to put the hypothesis before chemists who may have more facilities for such experiments than I possess.

Experiments made not enough; others to be made.

With regard to experiments of this kind I may remark, that all plants would not necessarily give like results. Although the phenomena of germination and growth possess the same general features in all kinds of plants, they must exhibit many points of difference when different families are compared. The observations of Saus-

All plants do not give like results:

examples. sure and others upon the relative absorbent powers of plants for saline solutions, afford us many examples of such differences. Thus Trinchinetti[4] found that *Mercurialis annua* and *Chenopodium viride* absorbed much saltpetre and little common salt from a solution containing both salts. On the other hand, *Satureja hortensis* and *Solanum Lycopersicum* absorb much salt and little saltpetre. *Vicia Faba* takes up much salt, while *Mercurialis annua* absorbs much chloride of ammonium from a solution of both.

Ammonia and nitric acid in every part of plants; noticed as constituents of plants in analyses; not frequently enough to establish general diffusion. Such inquiry the basis of phytochemistry. Statements

Part of the salts of ammonia and nitrates, when taken up by the roots, must begin to be transformed immediately; but it has not been ascertained to what extent the transformation proceeds before reaching the leaves. If the process be slow, then we may expect to find both ammonia and nitrates present in every part of a plant, except perhaps in the fully ripened seed. Again, if the fermentative action of albumen be in some cases accompanied by the production of ammonia, and if nitric acid can be formed by the oxidation of the latter in leaves, we have a second distinct cause for the general diffusion of ammonia and nitric acid in the juices of plants. Ammonia and nitric acid are noticed as constituents in the results of analyses of many plants, especially in those made about twenty or twenty-five years ago. In some instances the presence of the ammonia may have been owing to putrefaction or the action of reagents; but such an objection cannot be urged against the newer analyses, in which better processes were employed and most of the probable sources of error known. These isolated examples, some of them also being liable to the objection just stated, though proving that both ammonia and nitric acid exist in considerable quantity in certain plants, would not suffice to establish their diffusion in all plants. The establishment of such a fact is obviously of the greatest importance, because it must serve as the indispensable basis to all inquiries concerning the changes which take place during the growth of plants, and the influence of chemical agents upon those changes. From this point of view I undertook to collect together all the statements concerning the presence of ammonia and nitric acid in plants made up to the present time, and to exa-

[4] *Sulla faculta assorbente della radicii*, quoted in Gmelin's Handbuch, Bd. viii.

collected and new experiments made by author.

mine a large number myself. I have combined the results of previous observers, which are more numerous than might be supposed, with the extensive series obtained by myself, in the form of a table which will be found further on, in which the plants are arranged according to the natural families.

Author's obligations to Rochleder.

This is the place to acknowledge my obligations to Professor Rochleder's *Phytochemie*, in gathering together the results of previous experiments. Indeed, whatever of completeness the table possesses in this respect, is justly due to the assistance which his labours have afforded me.[5]

Before describing the processes employed to detect the ammonia and nitric acid in the plants contained in the table, I will make a few observations upon the probable transformations which ammonia undergoes in plants, and mention some experiments which I made in connection with this subject.

Quantity of ammonia in plants small and variable; more in them on rich than on barren soils, in the shade than in sunshine; not applying to ammonia formed during growth.

Whether the ammonia found in plants be wholly derived from the soil, and therefore representing a part of the still unassimilated food, or be also in part a product of the transformations occurring during their growth, the quantity must necessarily be small and variable; it may even be that no appreciable trace could be found in one specimen of sap while abundance may be found in another. As we might naturally expect, plants grown upon rich soils or upon artificially manured land, gave more than those grown upon dry, barren soils. The position of a plant with regard to sunlight appeared to materially affect the ammonia in the sap and leaves. Thus plants which had rankly grown upon a rich soil in the shade, always seemed to contain more ammonia than those which had grown under the full influence of sunlight. Perhaps this observation would not apply to ammonia resulting from transformations of growth, and which would be chiefly found in flowers and in the descending sap in the bark. Here, the greater the energy of growth, or in other words the greater the amount of sunlight, under other

[5] Professor Rochleder's work (*Phytochemie von Friedrich Rochleder, Med. Dr. and Prof.—Leipzig, verlag von Wilhelm Engelmann*, 1854), is the first systematic attempt made to connect the form of plants with their chemical composition. More recently Professor Rochleder has written the part of the eighth volume of Gmelin's *Handbuch der Chemie*, devoted to phyto-chemistry, upon the same plan. The two works supplement each other, and will, no doubt, contribute greatly to the advance of this branch of science. I regret that I had not an opportunity of using the second work in the construction of my table.

necessary conditions, the more ammonia may be formed. European grown tobacco, especially that grown in North Germany, Belgium, and the northern departments of France, contains more ammonia than that grown in tropical countries. Perhaps this increased quantity is due to unassimilated ammonia derived from the soil, while the large quantity of ammonia contained in the Cinchona barks may be derived from the transformation of albuminous bodies.

Analogous observations of others.

I am anxious that the preceding observations should be considered merely as suggestions, and not as positive opinions. Yet they derive some interest from analogous observations made from time to time by others. For example, Stenhouse found that *Cytisus scoparius* contained more of the basic substance sparteine, when grown on sandy, sunny spots, than when it luxuriantly vegetated in the shade. In like manner Pless has shown that *Erysimum alliaria* produces only oil of mustard when grown upon sunny places, but in shady places produces both oil of mustard and oil of garlic.

Associated constituents of each plant given in table. No conclusion yet deducible from these.

In the table containing the names of plants in which ammonia and nitrates have been detected, I have added a column containing the names of the acids, bases, bitter substances, etc., which are found associated in each plant. In the present state of our knowledge, no deductions of any value can be drawn from such associations, but it is obvious that we should always keep them in view in chemical experiments upon plants. But not only should we know the constituent proximate principles of a plant as a whole, but those of each organ separately; we would then be able to ascertain where particular substances were first formed, and where others ceased to be present. The difference between the composition of the ascending and descending sap should be particularly attended to.

Origin of odoriferous bodies most obscure; probably connected with changes of azotic bodies,

Perhaps the odoriferous principles of plants are those among the proximate constituents whose origin is most obscure. They belong chiefly to the following categories: 1. volatile acids related to alcohols, aldehydes, ethers; 2. carburets of hydrogen, oxygenated substances derivable from them. The former class appears to be more frequent in flowers and fruit where the process of deoxidation is feeble. Both of them appear to be somehow connected with the transformations of azotic bodies, and may in many cases be regarded with considerable probability as the excess of carbon and hydrogen separated in the pas-

sage of one body into another, especially of those belonging to the class of amides. The circumstance that the production of many essential oils is increased in the direct rays of the sun seems to favour such a view. In the case of such a plant as *Calotropis procera*, which is odoriferous in the sunlight and odourless in the shade, the esssential oil is obviously a kind of excretion. and therefore excretions.

There can be no doubt that some azotic bodies can only be formed under the influence of sunlight, but there are others which can certainly be generated without it. Thus asparagine is perhaps more abundantly formed in darkness than in sunlight, and when so produced, appears to be rapidly transformed if the plant be exposed to light. Young plants of the vetch, for example, when grown in a dark cellar, contain a great deal of asparagine, which disappears with considerable rapidity on exposing them for a day to sunlight. The late Professor Gregory it was who first suggested, I believe, that amides are perhaps the first bodies formed in plants. The existence of a vegetable acid in the sap would fulfil the chief condition, as it would always find itself in the presence of ammonia absorbed by the roots. The amides might be of two classes,—that is, we might have amides derived from ammonia salts of organic acids by the loss of water, or in which the hydrogen of the ammonia would be replaced by an oxygen compound, and would be either neutral or acid; and others in which the hydrogen would be replaced by a carburet of hydrogen, such as the so-called compound ammonias. Both may, and no doubt are, simultaneously formed in most, if not all plants, but it is probable that the predominance of one or other class may be characteristic of some families. In seeds with endosperms, and in which none of the acids analogous to malic acid or to oxalic acid occur, it may be that the first stages of growth depend upon the production of compound ammonias. When acids of the kind mentioned are present, the formation of the other class of amides may be most prominent. Asparagine, which only occurs in plants containing malic acid, may be but the type of a number of similar bodies formed with other acids. Thus oxamide, or rather a body bearing to it the same relation that asparagine does to malamide, may fill the same functions in plants containing oxalic acid as asparagine does in those containing malic acid. I made some experiments with *Oxalis Acetosella* in order to determine whether such a

Some azotic bodies formed without sunlight.

Amides the first bodies formed;

might be of two classes.

Circumstances under which each class may be formed.

body existed in it, but have not as yet obtained any definite results.

Other reactions which seem to show that ammonia is the starting point.

Besides the conclusions which may be drawn from the products of putrefaction and oxidation of the albuminous bodies, as already stated, other reactions seem to show that the substitution of the hydrogen molecules of ammonias by carburets of hydrogen, etc., is the process by which the azotic bodies of plants are built up. Wurtz, Rochleder, Wertheim, and Anderson, have shown that the whole, or a part, of the nitrogen of the organic bases may be separated as methylamine or similar bodies; while, on the other hand, the existence of several of these bodies in plants has been established by Dessaignes, Wittstein, Wicke, and myself. It may be that the first stage is the formation of a salt of ammonia with an organic acid, which, by loss of water, becomes an amide, and by deoxidation in the leaves, an ammonia base. If the latter class of bodies be formed in this manner in plants, we may expect to find traces of them where their presence has not hitherto been suspected. Plants growing upon natural soils must of course contain, at any given moment, but a very small portion of such bodies, even assuming their universal diffusion; a larger proportion would be found in those grown upon highly manured soils. It accordingly occurred to me that I might very largely increase the quantity, in case they are found at all, by growing some plants upon land dosed with azotic manures. With this object I divided a piece of ground into patches of two square yards, separated by deep trenches. One patch was left unmanured, and the other ten were manured with three classes of azotic manures, as follow:[6]

Experiments to ascertain whether compound ammonias are formed in plants.

I. Undecomposed animal matter, - - -	1.—112 lbs. of fresh cow's blood.
	2.—7 „ of dried horse flesh.
	3.—6 „ of powdered dried sprats, and 31lbs of salted sprats.
II. Manures containing ready formed ammonia,	4.—Farmyard dung.
	5.—14 lbs. of dried night soil.
	6.—14 „ of Peruvian guano.
	7.—14 „ of sulphate of ammonia.
	8.—14 „ of chloride of ammonium.
III. Nitrates,	9.—14 „ nitrate of potash.
	10.—14 „ nitrate of soda.

[6] I owe to the kindness of Dr. Kirkpatrick, the Director of the Agricultural Department under the Commissioners of National Education, the means of making these experiments. He not only placed the piece of ground at the Model Farm, Glasnevin, at my disposal, but afforded me every other facility in his power in carrying them out. It is not

Upon the patches so manured, as well as on the unmanured patch, two varieties of beet (long red mangel wurzel and sugar beet) were grown. At the commencement of last winter they were examined for ammonia, etc. For this purpose about 15lbs. to 20lbs. of the roots were cut into thin slices and boiled with water (free from ammonia) to which a small quantity of sulphuric acid was added, until the whole was reduced to a pulpy mass; this was strained through bags and pressed; the strained decoction was then distilled, the distillate treated with hydrochloric acid and evaporated carefully to dryness. A residue was obtained from the roots grown upon each plot treated in this manner, but very variable in amount, being apparently most abundant from the blood and salts of ammonia.

Process employed to separate ammonia and bases.

The series of dried residues obtained in this way were next successively submitted to the same process of examination, as follows:—The dried mass was treated with a mixture of anhydrous ether and alcohol, which in every case dissolved a part; the insoluble part was chloride of ammonium, as was shown by a determination of the per-centage of platinum in the precipitate which it formed with chloride of platinum.

The alcoholic solution was distilled to separate the alcohol and ether, the residue was dissolved in the smallest possible quantity of water, and the solution divided into two unequal portions. A concentrated solution of chloride of gold was added to the larger portion, forming about two-thirds of the whole, by which a yellow precipitate was thrown down. The remaining one-third of the liquor was then added to the portion containing the precipitate, and the whole allowed to digest at a very gentle temperature; when perfectly cold it was filtered to separate the precipitate, a few drops of the gold solution were

the only occasion upon which he has shown his desire to further scientific experiments in connection with agriculture. Now that a great number of model farms are established, it is to be hoped that the public will see the importance of encouraging the carrying out of such experiments as are required to solve important questions in agriculture, and which could not be made by private means. This would be one of the most important advantages to be derived from the present agricultural organization, and would be more than equivalent for the whole sum spent in their support. I wish also to acknowledge my obligations to Mr. C. F. Patterson for the care which he devoted to the plots: indeed, without his kind assistance, I could not have made the experiments at all. I am indebted to Mr. Ritchie, of Belfast, for the greater part of the manures.

added to the filtrate, which was then set aside over sulphuric acid.

The precipitate remaining on the filter was dissolved in boiling water, and the solution set aside over sulphuric acid in the dark. In the course of a couple of days the whole or a greater part crystallized out in the form of short cube-like prisms and octohedra, having all the characters of the gold salt formed by trimethylamine. The following determinations made with salts repeatedly crystallized out of a boiling solution, from which the crystals separated on cooling, confirmed this supposition:

Trimethylamine

1. 0.125 grammes of the salt gave 0.062 grammes of gold.
8. 0.205 " " 0.101 " "

which correspond in 100 parts to—

	calculated	found
1.	49.326	49.600
8.		49.268

It was not found practicable to determine the exact composition of the crystals in the other cases, but there could be no doubt of their identity with those analysed.

The mother liquor filtered from the precipitate as above, and set aside in the dark over sulphuric acid, gave after some time, besides crystals of the gold salt just described, some of other gold salts, among them fine bundles of lustrous golden orange-coloured needles and small micaceous scales. The quantity was, however, so small that no further separation could be attempted. In addition to ammonia, therefore, the presence of trimethylamine was ascertained in the roots grown upon all the plots, and the existence of traces of several other bases established with certainty in those grown upon plots 1, 7, 8, 9, and with considerable certainty in most of the others.

and some other bases formed in highly manured plants.

It is very probable that the volatile bases which have been mentioned from time to time as occurring in several plants belong to the same class as those formed in the roots just mentioned. Among them I may specially mention pastinacine, from the parsnip, in which, by a similar process, I also found trimethylamine, cicutine, from *Cicuta virosa;* the supposed volatile alkali of *Chaerophyllum bulbosum*, etc. Another fact of considerable importance in connection with this subject is the interesting obser-

Pastinacine, etc., probably only the same base.

vation of Kekulé and Von Planta, of the presence of methyleconine along with conine in hemlock. From some experiments of my own, I am inclined to think that methylenicotine is also often present in tobacco.

I shall now return to the description of the processes employed to detect ammonia and nitric acid in the plants named in the subjoined table, examined by myself.

Processes used to determine the presence of ammonia in plants.

In order to determine if ammonia was present, the sap, expressed juice, infusion in cold or hot water, or decoction, as the case may be, and in some cases the flowers, young twigs, or young buds, were introduced into a small tin vessel, provided with a head and condensing-worm, and furnished with a small steam-pipe connected with a boiler. The latter was charged with water to which some lime water was added, and allowed to produce steam for some time, until half a gallon of the condensed water gave no trace of ammonia when evaporated with a few drops of hydrochloric acid, which was usually the case when about one-third of the water had been vaporised. The absence of all appreciable traces of ammonia in the steam employed having been thus secured, the steam was turned on until the volatile oils, etc., had passed over; a little baryta water, or a very dilute solution of caustic soda, was then added, and the distillate collected apart, treated with some drops of pure hydrochloric acid, and evaporated to dryness. The residue, if any, was chloride of ammonium or other volatile bases, always coloured with some organic substance; it was usually tested for ammonia in the ordinary way; but when a sufficient quantity was obtained, compound ammonias were sought for, as will be described further on. Sometimes ammonia came over with the volatile oil before the addition of the baryta water or solution of soda. Where the quantity of material was too small to admit of adopting the process just described, which was usually the case with saps, the distillation was effected in a glass retort with baryta water.

Difficulty of determining nitrates in plants; processes not usually described;

I found great difficulty in detecting a small quantity of nitric acid in a solution containing a mixture of organic substances, and still more in the determination of its amount. I sought everywhere for the description of the processes which others had followed, but with the exception of the indirect method described by Ville, I could not find one. If any have been published, they are not mentioned in any of the usually

available sources of information. It is to be regretted that the processes employed in the proximate analysis of plants have not been more frequently described in detail, for a knowledge of those processes is necessary to enable us to understand the exact value of the results. Again, the publication of a process prevents the reïnvention of it, and leads to its gradual improvement and simplification, or its substitution by a better one. Not having been able to find any, I successively devised several; but, with the exception of the one which I shall now describe, they were more or less unsuccessful. But even that which I finally adopted is very complicated and troublesome, and leaves much room for improvement. When, however, great care is taken, and the operations are not hurriedly done, very satisfactory results can be obtained. It is but right to add that, although the process be complex when we seek to isolate only a single constituent, it possesses the advantage of being readily made the basis of a process for the complete proximate analysis of plants.

benefit from publication of processes.

Author's process for determining nitrates.

The substances which may be present in the juice, infusion or decoction of plants, are: dextrine, gum, mannite, glucose, cane sugar, some of the gelatinous principles, glucosides, tannins, acids of the series which yield pyrogenous acids—malic, citric, fumaric, tartaric (also racemic or inactive tartaric acid), and aconitic acids; acids of the series homologous with acetic acid—acetic, etc., acids; lactic acid; acids homologous with oxalic acid—oxalic and succinic acids; bitter principles; colouring matters; amides—asparagine, etc.; alkalies; neutral azotized or albuminous bodies; chlorides of potassium, sodium, ammonium, etc.; sulphates of potash, soda, etc.; phosphates of potash and soda; nitrates of potash, soda, and ammonia. The organic acids will also be usually in combination with some base. All the substances just named will not, of course, occur together in any one plant, the existence of some of them in the same fluid being incompatible. Of the organic acids only one or two are usually found in the same plant, but as many as four or five may occur. As all nitrates are soluble in water, and those which are insoluble in alcohol almost invariably correspond to the salts of the organic acids present, insoluble in the same medium, the separation of the nitric acid present in the sap or juice of a plant involves the successive separation of every one of the

bodies above enumerated which may happen to be present. It is on this account that a process for the determination of the amount of nitrates in plants must necessarily be a process for the separation of all the proximate constituents of vegetables.

The sap or expressed juice, as the case may be (having been weighed, if a quantitative determination be made), is to be heated to boiling, in order to coagulate the albumen. A quantity of lime water is added to precipitate certain nitrogenous bodies not coagulated by heat, pectic, phosphoric, oxalic, etc., acids. This precipitate should be allowed to deposit, and when separated may be employed to determine the amount of the latter two acids. The sulphuric acid may also be thrown down with baryta. A stream of carbonic acid is then to be passed through the liquid to neutralize excess of lime and baryta. The liquor is then boiled, filtered, to separate carbonates of lime and baryta, and a few drops of sulphuric acid added to the liquor, again boiled, to convert any cane sugar present into glucose. Before performing this operation, the amount of deviation might be determined by the polarimeter, and again after boiling with acid, by which data for determining the amount of sugar would be obtained. The liquor boiled with acid is then carefully neutralized with baryta and made to ferment with yeast until the whole of the sugar is converted into alcohol. The fermented liquor is then distilled to remove the acohol, the quantity of which may be employed to control the previous determination of the amount of sugar. In juices containing a very large amount of sugar and of salts of malic, etc., acids insoluble in alcohol, a portion of the salts may be precipitated during the progress of the fermentation if the liquor happen to be somewhat concentrated. This is, however, of no consequence, because they are re-dissolved according as the alcohol is removed by distillation.

The liquor remaining in the retort after the distillation is carefully evaporated to dryness in a water bath, and the dried residue treated with anhydrous alcohol (distilled off lime, and not off carbonate of potash), which dissolves mannite, acetates and lactates of potash or soda (and a trace of citrate of soda, if present), etc. This solution I shall call B.

The residue after treatment with anhydrous alcohol is then treated with perfectly neutral anhydrous ether, to

remove colouring matter, resins, fats, and any peculiar crystalline body soluble in it but insoluble in alcohol, which may be present. This solution, which I shall call C, may be employed to determine the fats, etc.

The residue of this successive treatment with alcohol and ether is dissolved in the smallest possible quantity of water, and then treated with an alcoholic solution of oxalic acid, and set aside for some time with frequent shaking; the whole of the salts present will be decomposed, and oxalates of potash and soda formed, which, being insoluble, will be precipitated. The strongest alcohol should be used to dissolve the oxalic acid, and sufficient of the solution should be added to that of the residue in water to form a mixture much stronger than ordinary spirits of wine. In solution will be found hydrochloric acid, nitric acid, and all the organic acids present. An alcoholic solution of sulphovinate of silver is then to be added, and some recently prepared oxide of silver; chloride, oxalate, malate, citrate, aconitate, tartrate, and fumarate of silver will, if present, be separated. By allowing the whole to remain together for several hours, shaking the flask from time to time, and finally plunging it into hot water for some minutes, the sulphovinic acid set free will be neutralized by the dissolution of the oxide of silver, and there will now remain in solution only nitrate of silver and the excess of sulphovinate of silver. The solution is separated from insoluble compounds by decantation, and the alcohol distilled off; the residue left in the retort is boiled with water to which baryta is added, by which the whole of the silver is thrown down, and the sulphovinic acid decomposed, the sulphuric acid being precipated by the baryta according as it is set free. The excess of baryta may then be removed by passing a stream of carbonic acid through the liquid, and then boiling it. The liquid, filtered and evaporated to dryness, yields nitrate of baryta.

Solution B may be employed for the determination of lactic and acetic acids, mannite, etc., if present. Solution C and the silver salts of organic acids may likewise be employed for the determination of the different bodies contained in them.

List of Plants in which the presence of Ammonia and Nitric Acid has been observed.

Plants examined arranged according to Orders.	Parts of Plant used. Ammonia.	Nitric acid.	Acids, bases, etc., which occur in each plant.
RANUNCULACEÆ.			
Helleborus niger, ...	Root—*Feneulle & Capron*	...	Helleborine (*base ?*), gallic acid. ?
MENISPERMACEÆ.			
Jateorrhiza palmata (cocculus palmatus) (*calumba root*)	..	Root — *Boedeker*	Columbic acid, probably malic acid. Colombine (*bitter, non-nitrogenous*) Berberine (*base*)
Animirta cocculus (A. paniculata) (*fruit the cocculus indicus*)	..	Seeds — *Pelletier & Couerbe*	Malic acid, menispermine (*base*)paramenispermine, picrotoxine (*non-nitrogenous*), fat oil.
CRUCIFERÆ.			
Nasturtium officinale—*Water-cress*	...	...	Yields a sulphur oil.
Cochlearia officinalis—*Scurvy-grass*	Fresh plant — *Guiret*	Fresh plant, extract — *Gutret, Tordeux*	Yields oil of mustard.
Erysimum alliaria—*Sauce alone*	...	...	Myrosine, yields oil of mustard and oil of garlic (grown in sunny places only oil of mustard *Pless*)
Isatis tinctoria — *Wood*	Juice — *Chevreul*	Juice — *Chevreul*	Acetic acid, myrosine, white indigo.
Brassica Oleracea. β. viridis. *Lin.*	...	Juice of fresh plant—*Schrader*	
„ „ botrytis. *Lin.*	Juice — *Tromsdorff*	...	
„ „ *Common sea cabbage*	...	*Juice—Sulliv.*	Myrosine.
„ rapa— *White stone turnip*	Juice—*Sulliv.*	*Juice—Sulliv.*	Myrosine, fat oil.
„ campestris — *Orange jelly*	Juice—*Sulliv.*	Juice — *Sulliv.*	Myrosine, fat oil.
„ *Fettercairne green-top Swede*	Juice—*Sulliv.*	Juice—*Sulliv.*	
„ *Skirving's purple-top*	Juice—*Sulliv.*	Juice—*Sulliv.*	
„ napus—*Rape*	Juice—*Sulliv.*	Juice—*Sulliv.*	Yields a sulphur oil, myrosine, fat oil.
Sinapis alba—*White Mustard*	Fresh plant—*Sullivan*	...	Citric and malic acids, Hydrosulphocyanate of Sinapine, fat oil.
Raphanus sativus—*Radish*	...	Juice—*Sulliv.*	Acetic acid, myrosine, yields a sulphur oil, fat oil.
RESEDACEÆ.			
Reseda luteola—*Weld*	...	Fresh plant — *Sullivan*	Luteoline (*non-nitrogenous*), fat oil.
MALVACEÆ.			
Althaea officinalis—*Marsh Mallow*	...	Fresh plant — *Sullivan*	Malic acid, asparagine; starch and mucilage.
TILIACEÆ.			
Tilia (Europæa ?)—*Linden tree*	Sap washed out of cambium; decoction of young twigs —*Langlois*	..	Acetic acid, malic acid, ? sugar, gum, gallic acid.
ACERACEÆ.			
Acer Pseudoplatanus — *Sycamore*	Sap in April—*Sullivan*	Sap in April—*Sullivan*	Fruit sugar (*in descending sap*), cane sugar.

Plants examined arranged according to Orders.	Parts of Plant used. Ammonia.	Nitric acid.	Acids, bases, etc., which occur in each plant.
SAPINDACEÆ.			
Æsculus Hippocastanum—*Horse-chestnut*	The young chestnuts with the pistils immediately after the falling off of the flower—*Vauquelin*	...	Acetic and oxalic acids, ? tannine, Æsculine, saponine, ? crystallizable bitter substance.
VITACEÆ OR AMPELIDEÆ.			
Vitis vinifera—*grape vine.*	Sap of vine drawn in March—*Langlois*	Sap of vine drawn in March—*Langlois*	Tartaric (*racemic sometimes*) and malic acids, lactic acid (*in sap, ? Langlois*) tannine, fruit sugar, fat oil.
OXALIDACEÆ.			
Oxalis crassicaulis	Stems—*Payen*	...	Oxalic acid, Pectine.
„ Acetosella—*Wood-sorrel*	Fresh plant—*Sullivan*	Fresh plant—*Sullivan*	
TROPÆOLACEÆ.			
Tropaeolum majus—*Indian cress*	..	Fresh plant—*Sullivan*	Malic acid, a sulphuretted oil (*allyle compound ?*)
XANTHOXYLACEÆ.			
Xanthoxylon clava Herculis—*Prickly ash*	Bark—*Chévallier and Pelletan*	...	Xanthopicrite (*base ?*), acetic acid, tannine.
SIMARUBACEÆ.			
Picrasma (Picræna) excelsa—*Bitter wood or common Quasia*	Wood—*Pfaff*	Wood—*Pfaff*	Quassite.
Simaruba amara *or* officinalis	Bark of root and lower part of trunk—*Morin*	...	Malic acid, oxalic and acetic acids, Quassite.
„ Guianensis	Ditto	..	
LEGUMINOSÆ. *a Papilionaceæ.*			
Cytisus (Sarothamnus) scoparius—*common broom*	...	Fresh twigs macerated in water—*Sul.*	Sparteine (*base*), scoparine (*colouring matter*), both more abundant on sandy, sunny spots than when the vegetation is luxuriant upon shady ground—*Stenhouse.* malic acid.
Dipterix odorata—*Tonka-bean*	The Tonka bean *Boullay and Boutron-Charlard*	...	Malic acid, cumarine, sugar.
Glycerrhizza glabra—*Liquorice*	Roots distilled with water—*Winkler*	...	Oxalic and malic acids, asparagine, glycerrhizine, starch
Robinia Pseudacacia — *Locust tree*	Root—*Reinsch*	...	
Vicia sativa—*common vetch*	Young shoots—*Sullivan*	...	Pectine, asparagine (*in young shoots*). Legumine starch (*in seeds*).
Phaseolus vulgaris	Young shoots—*Sullivan*	...	Asparagine (*in young shoots*), starch (*in seeds*).
b Cesalpinieæ.			
Cæsalpinia crista	Wood — *Chevreul*	...	Acetic acid.
Hœmatoxylon capechianum—*Logwood tree*	Wood — *Chevreul*	...	Acetic and oxalic acids, Hæmatoxyline.
ROSACEÆ. *a Amygdaleæ.*			
Prunus Spinosa—*Blackthorn*	Flowers and young twigs distilled with water—*Sullivan*	...	Malic and citric acids, tannine, amygdaline, phloridzine, gum, glucose, fat oil.

Plants examined arranged according to Orders.	Parts of Plant used.		Acids, bases, etc., which occur in each plant.
	Ammonia.	Nitric acid.	
Prunus insititia—*Bullace plum*	Fruit stone—*John*	...	Malic acid, amygdaline, phloridzine, gum, glucose, and fat oil.
b Pomeæ.			
Pyrus Malus—*Apple tree*	Sap in April—*Sullivan*	Sap in April—*Sullivan*	Malic, citric, and gallic acids, tannine, phloridzine, and probably valerate of oxide of amyle, glucose, pectine series.
„ communis—*Pear tree*	Flowers yield Propylamine (*Trimethylamine*)—*Wittstein*	...	Malic acid, some of the pectine series, phloridzine, glucose, amygdaline, acetate of oxide of amyle.
„ (*sorbus*) Aucuparia-*Mountain Ash*	Flowers distilled with water yield Propylamine (*Trimethylamine*)—*Wittstein*	Sap—*Sullivan*	Tartaric, malic, and citric acids, sorbine, fermentable sugar (*glucose*), amygdaline.
Cratœgus Oxyacantha — *Oval berried hawthorn*	Flowers distilled with water give Propylamine (*Trimethylamine*)—*Wicke*	...	Tannine, amygdaline, glucose.
CUCURBITACEÆ.			
Ecbalium purgans (E. elaterium, Momordica Elaterium)—*Squirting cucumber*	...	Expressed juice—*Braconnot*	Elaterine (*crystalline non-nitrogenous body*), malic acid?
Lagenaria vulgaris—*Bottle gourd*	Pistil—*John*	Pistil—*John*	
Cucumis sativus—*Common Cucumber*	Green fruit—*John*	Green fruit—*Sullivan*	Tartaric acid (*Strauch*), malic acid, ? fat oil.
Cucurbita Pepo (Benincasa cerifera)—*White gourd*	Flesh of fruit—*Braconnot*	.	
„ ovifera — *Vegetable marrow*	Fruit—*Sulliv.*	Fruit—*Sulliv.*	
FICOIDEÆ.			
Mesembryanthemum crystallinum—*Ice plant*	...	Juice of plant and liquid of glands—*John*	Oxalic and malic acids.
GROSSULARIACEÆ.			
Ribes Grossularia—*Gooseberry*	...	Fruit—*Sulliv.*	Malic and citric acids, sugar, gum.
SAXIFRAGACEÆ.			
Saxifraga umbrosa — *London pride*	...	Fresh plant—*Sullivan*	
UMBELLIFERÆ.			
Apium graveolens—*Celery*	Sap of young roots—*Lampadius*	Entire plant—*A. Vogel*	Apiine, mannite.
Conium maculatum—*Hemlock*	Entire plant and seed	Juice of fresh leaves—*Schrader*	Malic and acetic acids, conine (*base*), methyleconine—*Kekulé and V. Planta.*
Æthusa cynapium—*Fools parsley*	Fresh plant—*Sullivan*	Fresh plant—*Sullivan*	Cynapine (*base ?*).
Fœniculum vulgare—*Fennel*	Young shoots—*Sullivan*	Young shoots—*Sullivan*	Stearoptene of Anise (*which yields hyduret of anisyle*), acetic acid.
Petroselinum sativum—*Parsley*	Leaves—*Sul.*	Leaves—*Sul.*	Malic acid, apiine, essential oil (*isomeric with oil of turpentine*), sugar.
Pastinaca sativa—*Parsnip*	Root (also trimethylamine)—*Sullivan.*	Root, alveole of leaves—*Sul.*	Pastinacine (*volatile base—Wittstein*), sugar.

Plants examined arranged according to Orders.	Parts of Plant used. Ammonia.	Parts of Plant used. Nitric acid.	Acids, bases, etc., which occur in each plant.
Daucus carota: *Common red carrot*	Root—*Sulliv.*	Root, alveole of leaves—*Sul.*	Malic acid, carotine (*colouring matter*), sugar, pectine series.
Red Surrey "	Root—*Sulliv.*	Leaves—*Sul.*	
White Belgian "	Root, leaves—*S*	Roots and leaves—*Sul.*	
CAPRIFOLIACEÆ.			
Sambucus nigra—*Common elder*	Flowers distilled with water—*Gleitsmann*, *Pagenstecher*	Bark—*Sulliv.*	Malic, acetic, and valerianic acids, grape sugar.
CINCHONACEÆ.			
Cinchona Calysaya *var.* vera.	Bark—*Reichardt.*	...	Quinine, quinidine, cinchonine, chinic, chinovic, and oxalic acids, pectine bodies, starch, tannine, etc.
" micrantha	Ditto Ditto	...	
" ovata *var.* erythroderma	Ditto Ditto	...	
" cordifolia	Ditto Ditto	..	
" Condaminea *var.* lancifolia	Ditto—*Reichel*	...	
COMPOSITÆ.			
Cichorium Intybus—*Chicory*	Root—*Juch*	Leaves—*Sul.*	Caoutchouc-like body, inuline.
" Endivia—*Endive*	Young plant—*S*	...	
Lactuca virosa—*Wild lettuce*	Milky sap or lactucarium—*Pagenstecher*	Leaves and stems at period of flowering — *Pagenstecher*, *Walz.* Lactucarium—*Pfaff & Klink*	Oxalic acid, valerianic acid (*Ludwig*), citric and malic acids (*Walz*), succinic acid, (*Kœnke*) lactucine (*Amidé?*), lactucone.
" sativa—*Common lettuce*	At period of flowering distilled with water *Sullivan*	Extract of plant some years old—*Bley*	Malic, oxalic, and succinic acids, lactucine, lactucone.
" altissima	...	Milky sap—*Aubergier*	Malic and oxalic acids, asparagine, a crystallizable bitter substance, etc.
Taraxacum officinale (Leontodon Taraxacum)—*Dandelion*	Juice—*Sulliv.*	Juice—*Sulliv.*	Taraxacine (*bitter substance*), inuline, caoutchouc-like body, mannite.
Sonchus oleraceus — *Common sow thistle*	Juice—*Sulliv.*	Leaves—*Sul.*	Caoutchouc-like body.
Calendula officinalis—*Marygold*	...	Leaves—*Geiger*	Malic acid, calenduline (*mucilaginous substance*).
Cnicus benedictus (Centauria benedictus)	...	Entire plant—*Morin*	Malic acid, cnicine (*a bitter substance*).
Carduus (Cnicus) lanceolatus—*Spear thistle*	..	Plant—*Sulliv.*	
Senecio vulgaris—*Groundsel*	Plant at period of flowering—*Sullivan*	...	
Achillea millefolium—*yarrow*	...	Entire plant, flowers—*Bley*	Propionic acid, achilleic (*malic?*) acid, achilleine (*bitter substance*).
" nobilis	Entire plant—*Bley*	...	Formic, acetic, and malic acids, tannine.
Matricaria Chamomilla — *Common chamomile*	...	Extract—*Joss*	Tartaric acid (?), malic and acetic acids, essential oil.
Artemisia Absinthium—*Wormwood*	...	Watery extract—*Braconnot*	Succinic acid (*probably also malic and santonic acids*), absinthine (*a bitter substance*).

Plants examined arranged according to Orders.	Parts of Plant used.		Acids, bases, etc., which occur in each plant.
	Ammonia.	Nitric acid.	
Tanacetum vulgare—*Tansey*	...	Fresh plant — *Sullivan*	Malic acid, tannine, gallic acid?, tanacetine (*non-nitrog.*), essential oil.
Helianthus tuberosus—*Girasole* (*Jerusalem*) *artichoke*	Young plant *Sullivan*	Tubers—*Payen*	Citric and Malic acids (*Braconnot*), oxalic acid and trace of gallic (*Payen*), inuline, pectine, glucose.
Helianthus annuus—*Sunflower*	Young plant—*Sullivan*	Pith of stalk—*John*	Malic acid, asparagine (*earliest period of development*), inuline, fat oil.
Dahlia variabilis—*Dahlia*	Tubers—*Payen*	Tubers—*Payen*	Citric and malic acids, asparagine (*in the germs of the tubers when grown in the dark*), inuline, etherial oil.
STYRACACEÆ.			
Styrax officinale	Storax-*Reinsch*	..	Benzoic acid and essential oil.
AQUIFOLIACEÆ.			
Ilex aquifolium—*Holly*	Bark and flowers—*Sulliv.*	...	Ilicine (*non-nitrogenous* ?).
OLEACEÆ.			
Fraxinus excelsior—*Ash*	Sap in April—*Sullivan*	Sap in April—*Sullivan*	Mannite, crystallizable bitter substance (*fraxinine*).
ASCLEPIADACEÆ.			
Cyanchum vincetoxicum	Root *Feneulle*	...	Malic and oxalic acids.
GENTIANACEÆ.			
Menyanthes trifoliata—*Bogbean*	Young plant—*Sullivan*	...	Malic and acetic acids, inuline, menyanthine (*a bitter substance*).
CONVOLVULACEÆ.			
Convolvulus arvensis	Plant—*Chevallier*	...	Malic and acetic acids.
" Batatas (Batatas edulis)—*sweet potato*	Fresh root of variety, with rose-colour ed rind — *Payen and O. Henry*	..	Malic and oxalic acids, starch, sugar.
Convolvulus sepium (calystegia sepium)—*Great Bindweed*	Plant—*Chevallier*	...	Malic and acetic acids.
BORAGINACEÆ.			
Anchusa tinctoria—*Alkanet*	Root—*Bolley & Wydler*	...	Tannine ? anchusine (*a bitter substance*).
Borago officinalis	Watery extract of entire fresh flowering plant—*Lampadius*	Watery extract of entire fresh flowering plant—*Lampadius*	Acetic acid.
SOLANACEÆ.			
Solanum tuberosum—*Potato*	Tubers, buds, leaves, fruit—*Sullivan*	Leaves—*Sulliv.*	Malic and tartaric acids, solanine, starch.
" dulcamara—*Bitter-sweet*	Leaves and stalks and fruit—*Sulliv.*	...	Malic acid, solanine.
" nigrum	Leaves and fruit	...	Malic acid, solanine.
" verbascifolium	Fruit and Stalks—*Payen and Chevallier*	...	Malic acid, solanine.
Lycopersicon esculentum — *Tomato*	Fruit—*Sulliv.*	..	Oxalic acid.

Plants examined arranged according to Orders.	Parts of Plant used. Ammonia.	Nitric acid.	Acids, bases, etc., which occur in each plant.
ATROPACEÆ.			
Atropa Belladona—*Deadly nightshade*	Expressed juice, entire plant—*Vauquelin, Brandes*	Expressed juice, entire plant—*Vauquelin, Brandes*	Malic, oxalic, and acetic (?) acids, fat oil, atropine, asparagine, esculine? (*a one year old extract of the leaves also contained asparagine*).
Datura Stramonium — *Thorn-apple*	...	Fresh plant, extr. some yrs. old — *Promnitz, Bley*	Malic and acetic acids, atropine, sometimes stramonine.
Hyoscyamus niger– *Henbane*	...	...	Malic and acetic acids, hyoscyamine.
Nicotiana Tabacum—*Virginian Tobacco*	Juice of leaves, etc. — *Vauquelin, Reimann, and Posselt*	Juice of fresh leaves—*Vauquelin, Reimann, and Posselt*	Malic and citric acids (*acetic acid* ?) nicotine, nicotianine, methylenicotine, (?) fat oil.
Nicotiana rustica—*Syrian Tobacco*	Fresh leaves, flowers—*Sullivan*	Fresh leaves—*Sullivan*	
LABIATÆ.			
Salvia officinalis—*Sage*	...	Plant—*Ilisch*	Malic acid, tannine.
Lamium purpureum	...	Juice of fresh plant—*John*	Malic acid.
Leonurus lanatus (Ballota lanata—Lin.)	...	Plant—*Jori*	Tannine.
PLANTAGINACEÆ.			
Plantago lanceolata—*Rib-wort*	...	Leaves—*Sul.*	
CHENOPODIACEÆ.			
Beta maratima—*Sea-beet*	...	...	Oxalic acid.
„ vulgaris β cicla—*Lin.*:	Root, crown, etc.—*Buchner, Payen*	Root, crown—*Buchner and Payen*	Citric and oxalic acids, pectase and pectose, sugar.
White Silesian	Root, alveoles, leaves—*Sul.*	Root, alveoles, leaves—*Sul.*	
Long, red mangel wurzel	Ditto—*Sulliv.*	Ditto—*Sulliv.*	
Yellow globe „	Ditto—*Sulliv.*	Ditto—*Salliv.*	
Orange „ „	Ditto—*Sulliv.*	Ditto—*Sulliv.*	
Red „ „	Ditto—*Sulliv.*	Ditto—*Sulliv.*	
Chenopodium (Ambrina), ambrosioides	...	Plant—*Bley*	
„ Vulvaria (olidum)	The plant exhales ammonia *Chevallier*, and propylamine—*Dessaignes*	...	Acetic acid. (Part of the ammonia exhaled is combined with acetic acid).
„ hybridum	Plant yields ammonia when distilled with water—*Sul.*	...	Malic and oxalic acids, starch, tannine.
POLYGONACEÆ.			
Rheum rhaponticum—*Rhubarb*	Stalks and leaves - *Sul.*	Stalks and leaves—*Sul.*	
Rumex obtusifolius- *Dock*	Leaves—*Sul.*	Leaves—*Sul.*	Oxalic and malic acids (*probably also tartaric*), chrysophanic acid (*rumicine*), tannine.
„ Acetosella—*Sheep's sorrel*	Leaves—*Sul.*	Leaves—*Sul.*	Oxalic and tartaric acids.
Polygonum tinctorium	...	Leaves—*Girardin and Preisser*	Oxalic acid (*Hervy*), acetic and malic acids (*Girardin and Preisser*), indigo, tannine.

Plants examined arranged according to Orders.	Parts of Plant used. Ammonia.	Parts of Plant used. Nitric Acid.	Acids, bases, etc., which occur in each plant.
ARISTOLOCHIACEÆ.			
Aristolochia Clematitis	Root	Root—*Frickinger*	Malic acid, tannine, bitter substance.
Asarum europeum	Plant—*Lassaigne and Feneulle.*	...	Acetic, citric, and malic acids, tannine, asarone (*non-nitrog.*).
EUPHORBIACEÆ.			
Hura crepitans—*Sandbox tree*	...	Milky sap—*Boussingault and Rivero*	Malic acid, tannine, gallic acid, acrid crystallizable substance (hurine) caoutchouc-like body.
Euphorbia hiberna—*Irish spurge*	Fresh plant—*Sullivan*	...	Euphorbine (*base ?*).
URTICACEÆ.			
Urtica dioica—*Nettle*	Waterydistillat from plant—*Bohlig*	....	Formic, acetic, malic, and oxalic acids.
Cannabis sativa—*Hemp*	Leaves, pollen —*Tscheppe, John*	Leaves—*Tscheppe*	Acetic and malic acids, fat oil (*containing an alkaloid according to Gastinell*), cannabine (*resin*).
Humulus Lupulus—*Hop*	Leaves, leaf-stalks, bark of roots and stems, male flowers, bracts, lupuline—*Payen, Pelletan, and Chevallier*	Leaves, leaf-stalks, bark of roots and stems, male flowers, bracts—*Payen, Pelletan, and Chevallier*	Acetic and malic acids, tannin, asparagine, essential oil (*an oil isomeric with oil of turpentine and valerol*), lupuline (*bitter substance*).
ULMACEÆ.			
Ulmus campestris—*Elm*	...	...	
PIPERACEÆ.			
Cubeba officinalis	Fruit—*Vauquelin*	...	Acetic acid, tannine, mucus.
Pothomorphe umbellata	...	Root—*N. E. Henry*	Malic and acetic acids, cubebine (*non-nitrogenous*), oil of cubebs (*isomeric with oil of turpentine*).
SALICACEÆ.			
Salix viminalis—*Common osier*	Young green twigs and buds—*Sul.*	Green twigs and buds — *Sullivan*	Tannine, salicine. ?
Populus nigra—*Black poplar*	Fresh buds—*Pellerin*	...	Tannine (*gallic acid*), malic acid, salicine, populine, ? essential oil.
BETULACEÆ.			
Betula alba—*Common birch*	Sap in April—*Sullivan*	Sap in April—*Sullivan*	Acetic and probably tartaric acids, sugar, fruit sugar (*in ascending sap*), tannine, betuline, (*a crystallisable resin*).
Alnus glutinosa—*Alder*	Sap in April—*Sullivan*	...	Tannine.
CORYLACEÆ OR CAPULIFERÆ.			
Castanea vulgaris — *Spanish chestnut*	...	Sap—*Vauquelin*	Acetic acid, sugar, starch.
Corylus Avellana—*Hazel*	...	Sap—*Sullivan*	Malic acid, ? fat oil.
Fagus sylvatica—*Beech*	Sap in April-*Sullivan*	Sap in April—*Sullivan*	Acetic acid, tannine (*gallic acid*), fagine(*a volatile base*), fat oil.
JUGLANDACEÆ.			
Juglans regia—*Walnut-tree*	Sap in April *Langlois*	Sap in April-*Langlois*	Lactic acid (? *Langlois*), acetic, malic, and oxalic acids, fat oil, tannine, juglandine(*non-nitrogenous*).

Plants examined arranged according to Orders.	Parts of Plant used. Ammonia.	Parts of Plant used. Nitric Acid.	Acids, bases, etc., which occur in each plant.
CONIFERÆ.			
Pinus sylvestris—*Scotch fir*.	Pollen—*John*	...	Formic and citric acids, tannine, pimaric acid, fat oil, oil of turpentine, pinipicrine (*bitter substance*).
„ abies	Pollen—*John*	...	Formic and malic (?) acids, tannine, pimaric acid, fat oil, oil of turpentine.
ZINGIBERACEÆ OR SCITAMINEÆ.			
Alpinia Galanga	Water distilled from root—*A. Vogel, jun.*	...	Oxalic and acetic acids, gum, Kœmpferide (*non-nitrogenous*).
MUSACEÆ.			
Musa paradisiaca—*Plantain*	...	Sap—*Fourcroy and Vauquelin*	Acetic, oxalic, malic, and gallic acids, tannine, sugar (*starch in unripe fruit*).
Musa rosacea	Expressed juice of stem—*Clamor Marquart*	...	Malic and acetic acids, tannine, sugar
AMARYLLIDACEÆ.			
Agave americana	...	Expressed juice—*Sul.*	
LILIACEÆ. *a Asphodeleæ.*			
Allium Cepa—*Onion*	Young plant—*Sullivan*	...	Acetic (?) and citric acids, pectic acid, tannine (*in Autumn*), sugar, sulphide of allyle.
Allium sativum—*Garlic*	Bulbs—*Sulliv.*	...	Sulphide of allyle.
„ Porrum—*Leek*	Young plant—*Sullivan*	...	
b Smilaceæ.			
Asparagus officinalis—*Asparagus*	Young shoots—*Sullivan*	Young shoots—*Sullivan*	Malic and acetic acids, asparagine.
PALMÆ.			
Areca Catechu	Fruit—*Morin*	...	Oxalic, acetic, and gallic acids, tannine, starch (in pith).
GRAMINEÆ.			
Triticum vulgare—*var.* hybernum—*Winter wheat*	Very young plants—*Sul.*	...	Mannite, oxalic acid, glucose, starch
Saccharum officinarum—*Sugar-cane*	...	Juice of cane—*Sullivan*	Oxalic, acetic, and malic acids, sugar, wax.
LICHENES.			
Cetraria islandica—*Iceland moss*	Plant—*John*	Plant—*John*	Fumaric, cetraric, and Lichenstearic acids, substances capable of being transformed into sugar (*lichen starch, etc.*)
Sticta pulmonaria	Plant—*John*	...	Lichen starch, probably cetraric acid or some analogous body.
Parmelia ciliaris	Plant—*John*	...	Lichen starch.
FUNGI.			
Agaricus campestris—*Common mushroom*	Plant—*Gobley*—*Sullivan*	...	Probably lichenstearic acid, fumaric, malic, and citric acids, mannite.
Agaricus stercorarius—*Dung agaric*	Plant—*Sulliv.*	...	
Boletus Grevillei—*Yellow boletus*	Plant—*Sulliv.*	...	Oxalic acid.
Exidia glandulosa—*Witches' butter*	Plant—*Sulliv.*	...	
Phallus impudicus—*Common stinkhorn*	Plant—*Braconnot*	...	Acetic acid, mannite.
Lycoperdon pusillum—*Dwarf puffball*	Plant—*Sulliv.*	...	

Plants examined arranged according to Orders.	Parts of Plant used.		Acids, bases, etc., which occur in each plant.
	Ammonia.	Nitric acid.	
Lycoperdon gemmatum — *Studded puffball*	Plant—*Sulliv.*	...	
Elaphomyces granulatus	Seed, peridium of the warty kind—*Blitz*	...	Mannite.
Helvella esculenta	Plant—*Schrader*	...	Fumaric, citric, malic, and lactic acids, mannite.
Peziza vesiculosa	Plant—*Sulliv.*	...	
Tuber cibarium—*Truffle*	Plant—*Riegel*	...	Fumaric, citric, and malic acids, mannite.
Sphacelia segetum—*Ergot of rye*	Yields a volatile alkali when distilled with water and potash—*Winkler.* This is also probably tri methylamine.	...	According to Dr. Léveillé, ergot of rye consists not merely of the small parasite, sphacelia segetum, but also of grain altered in its chemical composition.

Art. IV.—*On the influence which the individual constitution of Plants exerts upon the Seed.* By William K. Sullivan.

In the matured plant we have the final result of the action of all the causes which influenced its growth. These causes may be classed under three categories: cosmical, agrological, and morphological. To the first belong the several influences exerted by the mean distribution of heat, the temperature, the amount and distribution of rain, the variation in the amount of vapour in the atmosphere, the amount and quality of the sun's rays, the relation between the period of flowering and the length of the day. By agrological causes I mean the influence exerted by the special mechanical and chemical qualities of the soil in which the plant grows. The third class of causes includes: 1. the action which the *specific* morphology of the plant,—that is, the structure which it has in common with all the individuals of the species,—exerts upon the chemical and other changes occurring during growth; 2. and that exerted by the *individual* morphology, or the peculiarities of structure

Classification of causes which influence the growth of plants.

which each individual exhibits. These causes are not of equal generality: the order is, indeed, the reverse of that in which we have enumerated them.

Relations between chemical constitution and form not yet studied.

It so happens that the relations between the chemical constitution and the *individual* and *specific* forms of plants, have hitherto received very little attention, the former indeed none at all; and yet phyto-chemistry, especially from an agricultural point of view, should be based precisely upon a knowledge of the action of those causes. Impressed with the great importance of tracing this connection, I have attempted some experiments, which, although of a very fragmentary and not very conclusive character, may help to call attention to one of the most important subjects of inquiry, whether judged from a purely physiological or agricultural point of view. I shall begin with the individual morphological structure.

Former experiments upon bulbous roots.

In the years 1852 and 1853, I made, in the Museum of Irish Industry, in conjunction with my friend Mr. A. Gages, several hundred analyses of the bulbous roots usually cultivated. The results of these analyses led to the important conclusion, that the difference in the amount of water between the large and small roots, grown under similar conditions, in the same field, was generally greater than that produced by the action of different manures; a result which necessarily invalidated all experiments upon the comparative action of different manures upon turnips, beet, potatoes, etc., hitherto made, in which the influence of size was not taken into account, and this had been almost never done.

Part of bulb then employed.

The proportions of water, ash, and nitrogen, were determined upon a slice cut, in one series from the centre of the root and at right angles to the axis, and in another series in the direction of the other axis. Mr. A. Rehring, of Edderitz, having, however, shown that the amount of sugar contained in different parts of a beet root varied, being at a maximum in the thickest part of the body, and diminishing upwards and downwards, it appeared to follow that the per-centage of solid matter determined from the cross sections, would be sensibly higher than the mean of the whole root, and that from the section along the axis, sensibly lower than the mean. This distribution of the sugar is more or less in accordance with the structure of the bulb, which consists of alternate layers of vascular and cellular tissue, the sugar being contained in the latter, especially in those cells close to the vascular

Distribution of sugar in bulb.

tissue. A larger proportion of such cells would of course occur in the thick body than at the point of the root. A considerable portion of the azotic substance being found in the vascular tissue, it struck me that the law of distribution for the other proximate principles of the root might not be the same as that for sugar. With the view of determining this point, I made, during the last autumn and winter, the following experiments.

Other constituents probably differently distributed.

I.—A root of long red mangel wurzel, weighing 9 lbs. 15 ozs., and measuring 19 inches in length, had five cross sections cut from it, which gave, when dried, the following results:—

Experiments made to ascertain this.

	Per-centage of Solid matter.	Per-centage of Water.
1. Segment of crown, half-inch thick,	11.64	88.36
2. Segment of body immediately below the crown, ...	11.09	88.91
3. Segment of body three inches below section No. 2, ...	10.28	89.72
4. Segment of body four inches below section No. 3, ...	11.17	88.83
5. Points of root or forkings, . .	12.85	87.15

II.—A root of white Silesian or sugar beet, weighing 6 lbs. 11 ozs., and measuring 14 inches in length, similarly cut, gave:—

	Per-centage of Solid matter.	Per-centage of Water.
1. Segment of crown, ...	7.55	92.45
2. Segment of body, half-inch below crown,	8.75	91.25
3. Segment of body, taken three inches below No. 2, ...	10.45	89.55
4. Segment of body, taken three inches below No. 3, ...	11.55	88.45
5. Point of root, two inches long, .	12.13	87.87

According to these results, the maximum amount of solid matter is in the thin part of roots, which, according to Rehring, contain but little sugar. When the quantity of sugar is very considerable, the maximum may, however, be in the thickest part of the root.

Result of experiments.

The relative diminution of solid matter, as the size of an organ increases, appears to be a universal law within certain limits; and the proportion of nitrogen follows the same law. The young buds, just before bursting into leaf, contain more solid matter and nitrogen than when fully unfolded. In the case of cabbage, I have found, in

Influence of size upon relative amount of water in organs of plants.

two instances that I tried the experiment, that the increase of water from the young heart leaves to the external ones was quite regular. Large roots sometimes appear to form an exception to this law by containing more nitrogen than the smaller roots. Part of this nitrogen is often, however, derived from nitrates and ammonia, the quantity of the former being always greater in large than in small roots. It would appear, too, that part of the azotic bodies is expended during the production of the sugar, and that, consequently, the less sugar that is produced, the less of the azotic bodies will be lost.

New determination of solid matter in bulbous roots made upon the whole root.

Density of other roots determined.

Table expresses present average quality of Irish-grown roots.

Being desirous of ascertaining how far this gradual increase in the relative amount of solid matter towards the narrow parts of the roots would influence the difference between large and small roots, which former experiments, made in the Museum of Irish Industry, had established, I recently undertook to make a new series of determinations, not upon a segment of the root as before, but upon the whole root. Although it is now universally admitted that large roots contain more water than small ones, yet it seemed to me to be worth incurring the labour of this new series of determinations, if for no other purpose than to ascertain the actual condition of our green crop husbandry as regards quality. The results of this inquiry, which extended to nearly all the kinds of root crops now cultivated in Ireland, and in which much care was taken in getting average samples, will be found in the annexed table. Besides the actual determinations of water and solid matter, the results of which are given in the table, I made a series of determinations of the density of a great number of other roots, by a process to be described further on. So that, although but two roots from each locality were dried, these were selected as representing the average, as determined by the density of, perhaps, in some cases twenty roots. The table may, consequently, be considered to express the present average quality of Irish-grown roots, and will serve as a standard by which to determine the future improvements in the quality of our green crops, for which indeed there appears to be much room. Hitherto all the efforts of husbandmen seem to have been directed to quantity and none to quality. This is abundantly proved by the circumstance that the only test recognized at shows of agricultural produce, for determining the comparative merits of the specimens of turnips, etc., exhibited, is weight. It is to

be hoped that henceforward some better test than this will be introduced, and that prizes be awarded for improving green crop husbandry, and not for deteriorating it, as the present forcing system but too often tends to do.

Law of size not the immediate object of the new determinations.

However important the object above mentioned may be, it was not the immediate one I had in view in making this new series of determinations. That object was connected with the subject of this paper, and which I shall now enter upon.

An examination of the table alluded to shows, that although large roots almost invariably contain less solid matter than small ones, thus confirming the results of former experiments made upon segments and not upon the whole root, equal differences of weight between large and small roots are very rarely accompanied by equal differences between the amounts of solid matter; and this is not only true of all roots compared together, but even in many cases of roots grown in the same field under as nearly as possible similar conditions, as we shall see presently. To give a few examples from the table:—

Equal differences of weight not accompanied by equal differences of per-centage of solid matter;

The greatest observed difference of solid matter (10.81) is attended by a difference of weight of only 2lbs. 8¼oz., while the greatest difference of weight observed between two roots grown together (10lbs. 4oz.) shows a difference in per-centage of solid matter of only 2.40. A nearly equal difference of weight in another case (9lbs. 15¼oz.) gave a difference of solid matter of only 0.17 per cent. To what are we to attribute these extraordinary variations? If the experiments had been limited to a few specimens, they would be set down most probably to the action of the soil and manure; and no doubt both causes may have contributed to the result. But as similar variations, and sometimes to as great an extent, may be observed among roots grown under precisely the same conditions as to soil and manure, it is evident that an initial cause of difference must have existed in the germs from which they were produced. I was led to this opinion by observing that roots grown from inferior, and especially from mixed, seeds, but under precisely similar conditions as to soil and manure, varied very much in their composition, and did not follow exactly the law of size, while good, uniform, and fully ripened seed invariably followed that law. The following examples will illustrate this:—

cause of this

illustrated by examples.

I.—White Silesian beet, grown upon a strong clay soil, and manured with matter from cess-pools and sulphate of ammonia.

Mixed inferior seed. Weight of root.		Mixed inferior seed. Per-centage of solid matter.	Good uniform seed. Weight of root.		Good uniform seed. Per-centage of solid matter.
13 lbs. 4 oz.	... ...	8.75	7 lbs. 10½ oz.	... ...	11.94
12 „ 7½ „	... ...	6.43	6 „ 12¼ „	... ...	12.32
10 „ 5 „	... ...	9.75	6 „ 6½ „	... ...	12.80
8 „ 11½ „	... ...	9.92	6 „ 2½ „	... ...	13.09
5 „ 13½ „	... ...	7.52	4 „ 8¾ „	... ...	14.32
3 „ 0 „	... ...	12.74	2 „ 6½ „	... ...	16.92
2 „ 10¾ „	... ...	10.42	2 „ 12½ „	... ...	14.56
1 „ 12¾ „	... ...	10.42	1 „ 15¾ „	... ...	15.48

II.—Long red mangel wurzel grown on a light clay soil, and manured with farm-yard manure.

Mixed inferior seed. Weight of root.		Mixed inferior seed. Per-centage of solid matter.	Good uniform seed. Weight of root.		Good uniform seed. Per-centage of solid matter.
7 lbs. 6¼ ozs.	...	12.92	8 lbs. 6¾ oz.	...	12.84
7 „ 5½ „	...	6.94	6 „ 11¾ „	...	13.03
6 „ 15 „	...	12.49	8 „ 4 „	...	15.20
2 „ 8 „	...	16.33	1 „ 5 „	...	14.80
1 „ 2½ „	...	15.99	1 „ 5½ „	...	15.86
0 „ 10 „	...	14.30	1 „ 4¾ „	...	16.96

It would appear, however, that, although the initial cause of variation from the law of size is resident in the germ, the soil and manure may increase or diminish the amount of divergence.

Agricultural seeds not uniform.

The ordinary seed used by husbandmen is rarely the seed of plants grown upon the same kind of soil and with the same kind of manure, that is, under more or less analogous conditions, but rather a mixture of seeds from different localities and produced under the most various circumstances. If, then, there be really an initial cause of difference resident in the germ, we have a sufficient explanation of the difference which any one may observe between the quality of roots grown in the same field. Now an important question suggests itself, namely, is the initial cause of difference in seeds hereditary, or in other words, is it derived from the peculiar qualities of the plants which bore it? If this be so, the seed of each plant must transmit more or less of its individual qualities, as well as the specific ones, to the plants which they will produce, subject to the modifying influences of soil, manures, climate, etc.

One of the most striking differences in quality which roots exhibit is that of relative amount of solid matter, a difference which may be determined by ascertaining their specific gravity, the roots containing least water being densest. I therefore determined to try whether this property of density could be propagated. For this purpose I selected three roots of white Silesian beet of nearly the same size (2lbs. 6oz. to 2lbs. 7oz.), but exhibiting as great a difference in specific gravity as possible. I determined the specific gravities by means of a series of solutions of common salt, indicating differences of specific gravity equal to 0.005. I employed eleven solutions placed in wide-mouthed jars, numbered from one to eleven. The following table gives the specific gravity of each:—

Difference in quality of roots ascertained from specific gravity.

Mode of determining specific gravity of roots.

No. 1	...	1.025	No. 5	...	1.045	No. 9	...	1.065
2	...	1.030	6	...	1.050	10	...	1.070
3	...	1.035	7	...	1.055	11	...	1.075
4	...	1.040	8	...	1.060			

The root whose specific gravity was to be determined, having been washed, was plunged into each successive solution until it floated fairly. We shall suppose a root sinks in solution No. 5, but floats in No. 7, its specific gravity may be considered as the mean, or 1.050; it ought consequently remain for a moment in any part of No. 6 solution, slowly rising towards the surface, if its specific gravity lies between 1.045 and 1.050, or sinking if it be between 1.050 and 1.055. For all practical purposes intervals of 0.005 are quite enough.

The roots whose specific gravities were thus determined were planted and allowed to produce seed, which was sown, and the roots produced from them examined. The following table gives the results:—

Experiments to determine whether the quality of density in roots could be transmitted to the seeds;

Specific gravity of parent root.	Weight of roots grown from parent seed, and per-centage of solid matter.					
	14 oz. to 20 oz. in weight.		32 oz. to 40 oz. in weight.		48 oz. to 60 oz. in weight.	
	Per-centage of solid matter.		Per-centage of solid matter.		Per-centage of solid matter.	
	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.
1.070	18.83	17.46	17.74	15.55	16.15	14.80
1.050	15.91	14.52	15.35	13.65	15.47	13.89
1.030	10.11	9.12	10.56	9.20	8.75	7.87

not sufficiently numerous to establish a law,

The experiments which I have made upon this deeply interesting subject are not sufficiently numerous or varied to establish so important a law as that supposed to exist. The results so far are, however, very remarkable; and whether they be the expression of a general law or an accident, they suggest a line of investigation which, if properly followed up, would assuredly yield some valuable and interesting theoretical and practical results.[1] Such experiments occupy a great deal of time, and demand great care and attention, and could only be successfully carried out by persons favourably circumstanced. To such I commend the subject; and as an additional argument, I would suggest its immense practical importance; for if such a law as I have supposed exists, we might raise the quality of most, if not of all, cultivated crops far beyond their present condition. In this respect there appears to be much room for improvement, as will be seen by a glance at the table containing the results of the determination of water and solid matter in bulbous roots. To increase the solid matter in all root crops (not including potatoes) by only one per cent., would be equivalent, in Ireland alone, to adding 5,000 acres to the area under cultivation!

but suggest investigation.

Importance of subject.

Probable cause of starting of roots.

In connection with this subject, it may be worth while to direct attention to the tendency which some mangel wurzel roots have of starting, as it is called; that is, of prematurely producing their flower-stalk. This of course exhausts the bulb of its azotic and saccharine principles, at the same time that it becomes woody. I have determined in several cases the relative amount of water and solid matter in roots just about to produce their flower-stalk, and never found the amount of the latter to exceed ten per cent. Dense roots appear never to exhibit that tendency; but in a crop of mangel wurzel in which the

[1] Since writing the above, I have found that M. Louis Vilmorin has proposed to improve the quality of the sugar beet by selecting the densest roots and growing seeds from them, and continuing this system of selection for several generations. I am glad that the results of my experiments are so fully in harmony with the experience of so eminent an agriculturist. He determines the density of the juice by cutting out, by means of a peculiar instrument, a piece of the root, which he rasps and presses. Small boxes containing all the apparatus required for the purpose are sold in Paris, and described by M. Vilmorin in a paper published in No. 5, for March 5, 1858, of that admirable periodical, the *Journal d'Agriculture Pratique*, edited by M. Barral.

per-centage of water is high, a considerable number of roots prematurely produce their flower-stalk as soon as the amount of water passes 90 per cent., which it does when the root reaches about three pounds in weight.

If by a judicious selection of seed, we could ultimately succeed in growing crops of roots having 15 or 16 per cent. of solid matter, it seems reasonable to suppose that we ought also to be able to develop some particular constituent which may be of more importance than the others. Thus some plants are grown for sugar, others for oil, others for fibre, etc.: it would certainly be a great advance in practical agriculture, if we could increase the relative proportion of each of these constituents in the respective plants which produce them. That such an initial difference of this kind may exist in plants, is, I think, proved by the different qualities of flax seed. Although the quantity and quality of fibre in the flax plant are very much influenced by the character of the soil, it is well known that all flax seeds will not produce the same quality of fibre when grown on the same land. Some will give a coarser fibre, others an extremely fine one. These differences in seed are of course the result of the influence of soil and climate upon the plants which bore them. There can be no doubt that, if experiments were made in this direction, most important results would be arrived at.

Probability that particular constituents may be developed by selecting seed.

In assuming that a plant can transmit its *individual* as well as its *specific* character through its seed to the plants which they produce, I do not mean to imply that the action of this cause may not be modified or wholly counteracted by the operation of the numerous other causes acting during the growth of plants, especially by the modifying influence which the soil exerts in virtue of its mechanical and chemical constitution. The contrary must indeed be the case; for the individual character is, in the first instance, as I stated in reference to the flax plant, the result of the action of such causes. Whatever be the cause or causes which produce the specific character of a plant, they appear to be so powerful as to predominate over the action of soil, climate, etc. The individual character is the measure of the effect of those causes in modifying the specific type. If we consider with Rochleder that the homœomorphism of plants, like the isomorphism of minerals, is the result of chemical

Individual character of plant may be modified by action of soil, etc.; specific character not.

Homœomorphism

constitution,—and the opinion seems rational,—all modifications in chemical constitution, whether they consist in the production of an abnormal substance or in the development of an abnormal quantity of one or more otherwise normal constituents, must, if they at all affect the seed, tend to perpetuate themselves—that is, to produce varieties. But nothing has yet been done, strictly speaking, to trace the kind of modification in chemical composition which most affects the germ.

of plants the result of chemical constitution.

Germs of plants having one flower-stalk more uniform than those having many.

In plants which produce but one flower-stalk, the whole of the germs are more likely to have the same chemical composition, and therefore the same structure, than where numerous flower-stalks are formed on different parts of the same plant. As each flower may be developed at different periods, the chemical constitution of the sap may vary very much within the intervals of time between the formation of the several germs, and consequently a different character may be impressed upon the germs of each flower. But even the seeds contained in the same capsule or pod often vary considerably in size and density. This is well seen in the leguminous seeds, but it may be often observed even in the case of such small seeds as those of the poppy. In timber trees, and generally in plants of slow growth, the constitution of the sap appears to be more constant and less liable especially to rapid modifications, or at least to those which affect the quality of the seed, than herbaceous plants. This is, perhaps, due in some measure to the various substances stored up in the vessels and cells, the produce of former growth, which serve to dilute or counteract the modification. On this account, it is much to be regretted that no one has determined whether the sap of the sugar maple presents as great a variation in composition as the quick-growing sugar cane and beet root.

Sap of timber trees more uniform than herbaceous plants.

Physical definition of a species.

Plants being composed of chemical molecules subjected to the action of the force or forces which produce the phenomenon of life, a *species* may be considered as simply a series of groups of such molecules, whose motions fulfil, under a certain relation of forces, the condition of the most stable equilibrium. So long as the relation of forces deviates very little from that which results in equilibrium, the type is constant, and any deviations from it are transitory. If the deviation be considerable, we may have: 1. a modification of the type, which may be in-

dividual if the deviation be transitory, or may result in the production of a variety if constant; or 2. the deviation taking place slowly and by successive steps, so as not to remove for a moment the molecules from the influence of the vital forces, a new condition of equilibrium may arise which would result in the development of a new species; or 3. the equilibrium may be so disturbed as to remove for a moment some of the molecules from without the sphere of vital force, the immediate result of which would be the death of the individual. If the transmutation of species be possible, the chances of the production of a new one may be set down at not less than one in several millions at least; while the conditions of equilibrium must impose a limit to the possible number of species which can exist under any given combination of physical conditions, and the most stable arrangements would naturally be those first attained. Now, from this point of view, the question of the extent to which a species might be permanently modified has not yet, so far as I am aware, been examined.

Probability of the development of new ones; possible number limited.

Experiments which should be made to determine the action of chemical agents upon plants.

Although the action of chemical agents upon plants has engaged the attention of many distinguished experimenters, yet beyond the great outline sketched by Leibig, very few positive data have been up to this acquired. Perhaps the circumstance, that hitherto the influence of chemical agents has been only studied upon the individuals of a generation, may in part account for this.

Carefully conducted experiments should therefore be made, to determine the action of chemical substances upon plants through the several successive generations obtained from a single parent plant. The seed of each plant, beginning with that of the parent plant itself, should be carefully distributed into several sorts, according: 1. to relative volume and density; 2. shape, in reference to normal type; 3. position of the flower on the plant, especially with reference to the action of solar rays; 4. period at which the flower of each seed (if single) or of each pod, etc., was developed; and so on. In this way, whatever slight influences might be exerted on the different seeds of the parent plant, might be gradually exalted after two or three generations. Such experiments should not be confined to one or two families of plants, because, no doubt, every family would be affected more or less differently by the action of the same causes.

Table showing the influence of Size upon the relative amount of water and solid matter in the usually cultivated Bulbous Roots.

Name of Root examined.	Weight of Root.				Per-centage of solid matter.		Difference between Large and Small Roots.		
	Large.		Small.		Large.	Small.	In weight.		In per-centage of solid matter.
	lbs.	oz.	lbs.	oz.			lbs.	oz.	
White Silesian, or Sugar Beet	12	7½	10	5	6.42	9.75	2	2½	3.33
	9	4	2	7½	8.73	11.19	6	12½	2.46
	5	10	2	7	13.40	15.34	3	3	1.94
	5	2	0	13½	14.86	15.89	4	5½	1.03
	4	9	1	1½	14.21	21.39	3	7½	7.18
	4	0	1	7¼	10.40	17.43	2	8¾	7.03
	4	0	0	12	12.94	15.32	3	4	2.38
	3	13¾	1	4½	15.78	19.78	2	9¼	4.00
	3	13½	1	10½	14.10	16.28	2	3	2.18
	3	11¾	1	8½	7.95	18.76	2	8¼	10.81
Long Red Mangel-Wurzel	11	8	2	9	9.54	10.84	8	15	1.30
	9	13	3	13½	10.59	12.24	5	15½	1.65
	9	5¾	2	1	9.41	14.09	7	4¾	4.68
	8	0	0	7	10.98	15.62	7	9	4.64
	7	4	1	0	10.79	15.91	6	4	5.12
	6	12½	1	5¼	12.28	14.68	5	7¼	2.40
	5	7½	1	6	11.83	13.46	4	1¼	1.63
	5	6½	2	10½	14.93	14.72	2	12	
	5	6	1	6	13.07	13.75	4	0	0.68
	4	8¾	1	2½	11.78	19.62	3	6¼	7.84
	4	6½	1	3	13.70	17.81	3	3½	4.11
	3	14	1	3	14.70	14.28	2	11	
	3	14	0	14	14.62	16.03	3	0	1.41
Red Globe Mangel-Wurzel	11	7	1	7½	10.36	10.53	9	15½	0.17
	9	8	1	15	7.05	9.20	7	4	2.15
	7	8	1	4	12.35	13.50	5	15	1.15
	7	2	1	1½	11.95	13.77	6	0½	1.82
	6	12½	1	9	11.34	13.80	5	3½	2.46
	6	12	2	4	12.82	14.64	4	8	1.82
	5	10	1	12	12 66	15.41	3	14	2.74
	5	6½	2	5	13.09	15.46	3	1½	2.37
	4	3	1	14¾	11.58	15.50	2	4¼	3.92
	3	15½	1	2	11.64	14.34	2	13½	2.70

Name of Root examined.	Weight of Root.				Per-centage of solid matter.		Difference between Large and Small Roots.		
	Large.		Small.		Large.	Small.	In weight.		In per-centage of solid matter.
	lbs.	oz.	lbs.	oz.			lbs.	oz.	
Orange Globe Mangel-Wurzel	12	1½	10	5½	5.24	6.66	1	12	1.42
	11	9	4	5	9.96	9.35	7	4	
	10	2	1	14	7.52	11.72	8	4	4.20
	9	10	2	5	11.88	12.58	7	5	0.70
Orange Globe Mangel-Wurzel	7	14	1	5	11.11	13.77	6	9	2.66
	7	0	1	3½	11.66	16.12	5	12½	4.46
	6	11	1	1½	10.80	18.34	5	9½	7.54
	4	10	1	1	9.99	16.60	3	9	6.61
	4	9	0	11	11.94	13.36	3	14	1.42
	4	2	0	11	10.68	15.19	3	7	4.51
	2	15	1	3½	14.32	14.10	1	11½	
Yellow Globe Mangel-Wurzel.	7	3	1	4	12.35	13.50	5	15	1.15
	5	11	1	12	12.66	15.40	3	15	2.74
	4	3	1	14	11.58	15.40	2	5	3.82
Purple-top Aberdeen Turnips *(Bullock)*	5	11½	3	3½	8.08	8.93	2	8	0.85
Skirving's Improved Purple-top Swedish Turnips	8	8	1	9½	10.69	11.07	6	14½	0.38
	7	13	1	9½	9.77	12.75	6	3½	2.98
	6	0¾	1	11½	10.61	12.23	4	5¼	1.62
	6	0	1	9	11.32	12.71	4	7	1.39
	5	10	1	9½	10.37	11.42	4	0½	1.05
Laing's Purple-top Swedish Turnips	9	10	1	8	9.95	11.21	8	2	1.26
	5	0¾	1	1	1.200	11.76	3	15¾	
Matson's Purple-top	5	9½	1	10	11.09	14.41	3	15½	3.32
East Lothian Purple-top	6	0	1	9	11.17	11.73	4	7	0.56
Ashcroft's Swedish Turnips	6	12½	2	6½	10.82	10.52	4	6	
Fettercairne Green-top Swedish Turnips	7	10	1	3	14.40	11.30	6	7	

Name of Root examined.	Weight of Root.				Per-centage of solid matter.		Difference between Large and Small Roots.		
	Large.		Small.		Large.	Small.	in weight.		in per-centage of solid matter.
	lbs.	oz.	lbs.	oz.			lbs.	oz.	
Green-top Swedish Turnips	6	6	1	7	10.71	11.68	4	15	0.97
	4	8	1	6½	11.69	11.74	3	1½	0.05
	3	8	1	0½	11.65	12.36	2	7½	0.71
	3	5¾	1	0½	12.80	11.78	2	5¼	
Swedish Turnips *(variety not determined)*	12	4½	2	0½	9.30	11.70	10	4	2.40
	11	11	1	1	10.10	11.98	10	10	1.88
	10	8	1	5½	10.35	12.03	9	2½	1.68
	9	13	1	14	9.91	12.19	7	15	2.28
	8	8	2	13	10.94	11.47	5	11	0.53
	8	2	3	11	11.20	12.93	4	7	1.73
	8	2	1	15	10.63	12.14	6	3	1.51
	7	15	1	9	10.93	12.13	6	6	1.20
	7	8½	0	14	10.08	12.34	6	10½	2.26
	7	1	1	5	18.06	12.79	5	12	0.73
	7	0	0	14	11.08	12.62	6	2	1.54
	6	12	1	5¼	12.66	20.01	5	7¼	7.35
	6	7½	1	3½	13.73	16.25	5	4	2.52
	6	1	1	2	11.18	12.30	4	15	1.12
	5	11	1	10	11.68	12.77	4	1	1.09
Orange Jelly Turnips	5	0½	0	14½	5.67	7.09	4	2	1.42
Parsnips	1	11	0	6¼	12.03	13.42	1	4¾	1.39
Red Carrots	1	9½	0	3	12.13	17.81	1	6½	5.68
	1	8¾	0	2¼	11.08	19.72	1	0½	8.64
	1	6	0	9½	12.02	11.51	0	12½	
Red Surrey Carrots	2	10¼	0	12	11.92	13.70	1	14¼	1.78
White Belgian Carrots	3	4	1	0	11.69	13.50	2	4	1.81
	2	6½	0	9¾	13.17	14.36	1	12¾	1.19
	2	0	0	11	12.06	14.04	1	5	1.98
	1	15¾	0	9	11.10	13.09	1	6¾	1.99
	1	1½	0	3½	12.72	14.09	0	14	1.37
	1	1	0	5	12.65	13.07	0	12	0.42

Art. V.—*Observations on the Motions and Sounds of the Human Heart during life, as witnessed in the case of M. Groux.* By Robert D. Lyons.

THE School of Medicine of the Catholic University had the honour of first introducing to the notice of the medical profession in this city the interesting case of M. E. A. Groux, of Hamburgh, the subject of congenital fissure of the sternum.[1]

Congenital fissure of sternum in M. Groux.

The almost unique conformation of parts observable in the centre of M. Groux's chest in front, offers to the physiologist and the practical physician a rare opportunity for making researches on the motions and sounds of the human heart and lungs during life. These organs are, by an anatomical condition of parts of almost unexampled rarity, partially exposed to touch and sight in the person of M. Groux. I had been familiar with the history of this instructive case, having for the last two or three years traced M. Groux's progress through Europe by the reports and publications of the various academies and learned societies before which he had been successively presented. On his arrival in this city I therefore felt that I was best carrying out the spirit of my duties to the Catholic University and to science in making the earliest possible arrangements for a *séance* with M. Groux, and in thus securing to our students the advantage of a personal observation of the phenomena of the heart's motions and sounds during life, in a case of such singular interest to the science of medicine.

It was likewise my desire to have an opportunity of making a full and patient exploration of M. Groux, with a view to the determination of some points of great practical moment to the physiologist and physician in connection with the phenomena of the heart and lungs in

[1] M. Groux was subsequently presented to the class at the Meath Hospital by Dr. Stokes, also to the Pathological Society, the Surgical Society, and at other places in this city. The Council of the Royal Irish Academy appointed a commission to investigate and report on M. Groux's case. The following gentlemen were nominated to form the commission: Sir Henry Marsh, Dr. Stokes. Dr. Corrigan, Dr. Cusack, Dr. Adams, Dr. Harrison, Dr. Law, Dr. Williams, Dr. Wilde, Dr. Lyons. The commission presented their report to the Council R.I.A., and it will appear in the ensuing volume of the Academy's Proceedings.

health and disease. The results of these researches I propose to put forward briefly in this paper. I have to tender my best acknowledgments to M. Groux for the kindness and patience with which he submitted to my prolonged and repeated examinations, continued on one occasion for nearly three hours.

Extreme rarity of this conformation.

The opportunities for observing the action of the human heart have been of great rarity, and our knowledge of its complicated functions, and the harmonious movements of its several parts, is almost wholly derived from analogical reasoning. Vivisections, or experiments performed on living animals, combined with observations on animals in which artificial respiration has been established after the destruction of the nervous centres, have abundantly shown us how the similar parts in the lower orders of creation perform their allotted functions; and on the whole it does not admit of reasonable doubt that our conclusions from experiment, and their applications to the explanation of the phenomena of the central organ of the circulation in man, are well founded. But it has ever been a grand desideratum in the Science of Medicine to have the opportunity of confirming our reasonings and conclusions by the direct and immediate exploration of the motions of the human heart by our organs of sight and touch, which constitute as it were the high court of appeal for the final decision of all physiological and pathological questions in dispute.

M. Groux's case the second on record.

The extraordinary rarity of the opportunities for submitting the phenomena of the human heart to these tests (of sight and touch) will be best appreciated when it is stated that since the time of the illustrious Harvey, the great practical expounder, if not the sole or even earliest discoverer of the circulation of the blood, M. Groux's case constituted till very recently only the second instance upon record in which the physiologist and physician have had the means of investigating by ocular inspection and the sense of touch the motions of the heart in man.[1]

The case observed by Harvey is of much interest in

[1] It is almost needless to say that we exclude from consideration here those instances of fœtuses surviving birth but a few hours, in which the heart was partially exposed by congenital malformation of the thoracic or abdominal walls. No account during life is preserved of the specimen of ectopia cordis abdominalis in the Museum of St. Thomas's Hospital, taken from a man æt. 47.

connection with M. Groux's, and as it has but rarely found its way into pages accessible to the general reader, I think it will be of advantage to cite its details in this place. The particulars of this case are given by Harvey in confirmation of his assertion that the heart is itself insensible. His account is as follows:— **Heart insensible.**

"Meantime, I cannot be silent on the remarkable fact that the heart itself, this most distinguished member in the body, appears to be insensible.

"A young nobleman, eldest son of the Viscount Montgomery, when a child, had a severe fall, attended with fracture of the ribs of the left side. The consequence of this was a suppurating abscess, which went on discharging abundantly for a long time from an immense gap in his side; this I had from himself and other credible persons who were witnesses. Between the eighteenth and nineteenth years of his age, this young nobleman, having travelled through France and Italy, came to London, having at this time a very large open cavity in his side, through which the lungs, as it was believed, could both be seen and touched. When this circumstance was told as something miraculous to his Serene Majesty King Charles, he straightway sent me to wait on the young man, that I might ascertain the true state of the case. And what did I find? A young man, well grown, of good complexion, and apparently possessed of an excellent constitution, so that I thought the whole story must be a fable. Having saluted him according to custom, however, and informed him of the king's expressed desire that I should wait upon him, he immediately showed me everything, and laid open his left side for my inspection, by removing a plate which he wore there by way of defence against accidental blows and other external injuries. I found a large open space in the chest, into which I could readily introduce three of my fingers and my thumb; which done, I straightway perceived a certain protuberant fleshy part, affected with an alternating extrusive and intrusive movement; this part I touched gently. Amazed with the novelty of such a state, I examined everything again and again, and when I had satisfied myself, I saw that it was a case of old and extensive ulcer, beyond the reach of art, but brought by a miracle to a kind of cure, the interior being invested with a membrane, and the edges protected with a tough skin. But the fleshy part (which I at first took for a mass of granulations, and others had always regarded as

Harvey's case in the son of Lord Montgomery.

King Charles directs Harvey to examine the case.

Plate worn on side to protect heart; the plate removed, and the heart exposed to touch.

Pulsating body erroneously supposed to be the lung.

Harvey determines this body to be the heart.

a portion of the lung), from its pulsating motions and the rhythm they observed with the pulse—when the fingers of one of my hands were applied to it, those of the other to the artery at the wrist—as well as from their discordance with the respiratory movements, I saw was no portion of the lung that I was handling, but the apex of the heart! covered over with a layer of fungous flesh by way of external defence, as commonly happens in old foul ulcers. The servant of this young man was in the habit daily of cleansing the cavity from its accumulated sordes by means of injections of tepid water; after which the plate was applied. With this in its place the young man felt adequate to any exercise or expedition, and in short he led a pleasant life in perfect safety.

King Charles examines the case with Harvey.

"Instead of a verbal answer, therefore, I carried the young man himself to the king, that his Majesty might with his own eyes behold this wonderful case: that, in a man alive and well, he might, without detriment to the individual, observe the movements of the heart, and with his proper hand even touch the ventricles as they contracted. And his most excellent Majesty, as well as myself, acknowledged that the heart was without the sense of touch; for the youth never knew when we touched his heart, except by the sight or the sensation he had through the external integument.

Heart emerged with systole, retreated with diastole.

"We also particularly observed the movements of the heart, viz., that in the diastole it was retracted and withdrawn, whilst in the systole it emerged and protruded; and the systole of the heart took place at the moment the diastole or pulse in the wrist was perceived. To conclude, the heart struck the walls of the chest, and became prominent at the time it bounded upwards, and underwent contraction in itself".

It is to be regretted that the observations of Harvey and his royal brother-investigator were not elucidated by the revelations of the stethoscope, the discovery of which was reserved for the nineteenth century.

We shall defer any discussion of the phenomena presented in this remarkable and unique case, hitherto all but forgotten in the records of medicine, until we have studied the phenomena presented in M. Groux's case.

Physical conformation in M. Groux:

M. Groux is about twenty-seven years of age, rather small in stature, but well formed, and of light and active build. He is habitually pale, or rather sallow in complexion, but his frame is well rounded; and though at

one period of delicate habit, and having once suffered from pleuritis of the left side, he has enjoyed excellent health for the last three years, during his active life of scientific peregrination. The remarkable condition which gives such interest to his case, is that of a congenital fissure in the middle line of the chest in front, covered by thin integument, and caused by want of union of the symmetrical lateral valves of the sternum or breast-bone, which in his person seems to have undergone development by two lines of ossification. The several points of ossification which correspond to the several subdivisions of the breast-bone, assumed, it may be supposed, the condition of two parallel ossific lines ranged on either side of the middle line. Arrest of ossific deposit in the mesial line took place, as the result of which the lateral halves of the bone in its further process of growth maintained an independent existence. Such I believe to have been the mode of development in this case, resulting in the subdivision of the sternum into symmetrical lateral halves with no connecting medium, except at the inferior end of the bone, where in the situation of the normal xyphoid cartilage, a strong and dense ligamentous band forms a means of junction. A long, narrow, irregularly-triangular fissure, depressed to a variable extent of one-fourth of an inch to one inch, is thus formed, the base of which is situated at the interclavicular space, and the apex is limited by the ligamentous band above mentioned. The fissure is of irregular outline on both margins, and presents a contraction at a point corresponding to the line of the fourth rib. The edges of the fissure are capable of being approximated, and even partially overlapped, by voluntary muscular effort on the part of M. Groux; while he is again capable of greatly increasing the width of the fissure by the action of another set of muscles. The accompanying diagram will explain the position, shape, and relative dimensions of the fissure, and will likewise enable us to explain with greater precision the motions and other phenomena of the several parts observable in it from above downwards; they will subsequently become the subject of description in detail.

He enjoys good health.

Separation of the breast-bone into two parts;

the fissure the result of arrested development, not a deformity.

Parts of breast-bone united below by ligament.

Fissure can be enlarged and contracted at will.

As shown in the diagram, the fissure may be subdivided into two portions—an upper and a lower: the latter is the more contracted and the more deep, and is likewise that in which the parts of the circulating apparatus are more difficult of detection and exploration by sight and touch. (This diagram is only a *plan* of the parts.)

Fissure divisible into an upper and a lower part.

The upper portion of the fissure is that part which is of more immediate interest in connection with the phenomena of certain parts of the heart and lungs brought into view.

The dimensions are, from A, sterno-clavicular articulation, to B, projection of sternum inwards on level of fourth rib, 3¼ inches; the lateral width from C to D in the quiescent condition is 1¼ inches; its greatest width at the same level, under the conditions of maximum expansion, as determined by me with all the requisite precautions, was found to be 2⅛ inches.

The letter X corresponds to the site of the ligamentous band which unites the two portions of the sternum inferiorly.

No discoverable sign of organic disease of the heart.

It is to be premised that the results of most carefully made and repeated stethoscopic examinations have satisfied me that there is no discoverable sign of organic lesion of the heart or its appendages in the case of M. Groux; and this opinion is fully concurred in by many eminent observers. The pulse is seventy-two, the cardiac action regular, and quite free from abnormal sound of any kind.

The following is the *procès verbal* of a carefully conducted examination of the phenomena presented in M. Groux. They were taken down by an assistant from my dictation.

Phenomena recognizable by Sight.—M. Groux in quiescent condition.

Two visible pulsations.

Obs. I. There is an oblong pulsation visible in the direction EF; it disappears with a long, slow, waving action, in the direction of the arrow. There is a slighter, fainter vertical pulsation in the direction of G H.

First pulsation compound.

II. Two movements are visible in the first pulsation; one a slow and apparently double motion, in which the body seems to come towards the surface, and take a direction from deep to superficial, and slightly from left to right; the other, shorter, more distinct, and with a direction from superficial to deep, and from before and the right backwards and to the left, being accompanied with an indrawing of the integument covering the point A.

Pulsation at xiphoid cartilage.

III. By careful observation, a slight motion is observable and above X, corresponding to the site of the ensiform cartilage; this motion becomes very distinct on forcible inspiration, being then attended with protrusion and retraction of a portion of integument about one inch in diameter.

IV. In the perfectly quiescent condition, only a very

slight and limited wave, continuous with the vertical wave H G, is visible at the root of the neck. The action of the vessels of the neck is not otherwise visible. **Slight wave at root of neck.**

V. In a favourable light, a manifest and appreciable interval of about two radial pulses is seen to exist between the oblique wave E F and the vertical wave H G. **Interval between waves E F and H G.**

VI. In the quiescent condition, there is only a very slight wavey movement at a point one inch below and one inch within the left nipple. **Slight apex movement.**

VII. The motions of E F and of X are manifestly not synchronous, the forward motion of E F corresponding pretty nearly with the retractile motion at X. **E F and X not synchronous.**

Phenomena recognizable by Touch.

VIII. The impulse of E F appears to be like that of a rounded and oblong body; it is produced apparently by a gradual but not very slow filling; its disappearance or subsidence is quick and rapidly completed; its first impact is distinctly single, but its disappearance is accompanied by the sense of a second deeper shock, when the fingers are permitted to follow its retraction. **Impulse of E F.**

IX. There is a very strong and vigorous resistance to the finger, pressed deeply into the seat of this pulsation. **Strong pulsation on deep pressure.**

X. A weak double and thrilling pulsation is felt on pressing deeply into the fissure opposite the second rib; a similar weak double thrilling impulse is felt on pressing the index finger deeply behind the sternal end of the right clavicle. **Double thrilling impulses.**

XI. The motion at X is not attended with perceptible impulse in the quiescent condition, but on deep inspiration a diffused impulse can be felt in that situation, but it is not synchronous with the motion E F. **Impulse at X visible on deep inspiration.**

XII. The cardiac impulse is readily perceptible to the hand placed flat on the precordial region; the apex beat is most perceptible through a surface of about an inch in diameter, midway between the left border of the fissure and the left nipple, and only slightly below the level of this latter point. **Cardiac impulse normal.**

Phenomena recognizable by Auscultation.

XIII. Both cardiac sounds are audible in this same situation, the first having somewhat of a clear and hard quality of tone; above this point, the first is fuller and has greater body of tone; the second is everywhere clear and distinct; both sounds are clearly audible on the inferior **Cardiac sounds normal.**

portion of the right fragment of the sternum; the first has here, however, a muffled character, and the second is not so loud as when heard to the left of the fissure.

Both sounds audible above clavicles.

XIV. In the upper part of the fissure, over the diagonal pulsation E F, boths ounds are conveyed to the ear with an intensely loud ringing character: they prescrve their natural relations as to duration; the second is sometimes most distinctly reduplicated.

Localised murmur in right carotid.

XV. With the bell of the stethoscope half above the clavicles, two sounds are very distinctly heard, the first of which is full and ringing, the second is here very clear, strong and loud, and predominates over the other.

XVI. Over the right carotid, both sounds are audible, the first being attended with a slight but very perceptible bellows murmur; I cannot detect this in the left: the second sound is very clear, loud, and certainly the predominant one in both carotids.

Second sound very intense throughout fissure.

XVII. With Groux's stethoscope behind the sternal end of the clavicles, both sounds are distinctly audible. Over E F, the sounds are the same as before; the second is perhaps the more intense and loud; the second sound is everywhere throughout the fissure most intensely loud; in the right carotid the same sound is heard as before, but there is much more difficulty in hearing the sounds of the left carotid with this instrument (a small glass bell, with a flexible india rubber tube fitted upon it).

Interval between E F and apex-beat.

XVIII. The diagonal impulse E F and the apex beats take place very nearly at the same time; the former, in my opinion, slightly precedes the latter. This is the more perceptible when the two are felt with the one hand. No pressure that can be safely borne can produce a murmur in the situation H G, though the stethoscope was pressed back so as nearly to touch the spine.

Great dilatation of E F.

XIX. In deep inspiration, followed by slow and complete expiration, the diagonal pulsating mass E F comes prominently forward and appears subdivided into two, by a kind of hour-glass contraction, and at the same time a very strong pulsation is seen and felt in the second and third intercostal spaces, especially when the tips of the fingers are pressed deeply in between the ribs.

Feather experiment.

XX. The feather experiment shows a distinct interval between the diagonal pulsation E F.[3]

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[3] This simple but very demonstrative experiment is thus performed: the feathered portion of an ordinary quill is made to adhere by the

XXI. With the sphygmoscopes, the diagonal motion precedes by a short but appreciable interval, the beat of the heart's apex.[4] **Sphygmoscopes show interval.**

Before discussing the phenomena presented in M. Groux's case, we may here insert a brief account of a somewhat similar instance of deficiency of parts, which constitutes the *third* example since the days of Harvey of a condition of the anterior wall of the thorax admitting exploration of the cardiac movements. **Details of a *third* case.**

Blumdahier, son of a master cartwright, a boy of fourteen, labours under a deformity, consisting chiefly in a very decided hump and a lateral curvature of the spine, accompanied by a deviation of the ribs, some of which are imperfect.

The inclination of the vertebral column commences about the middle of the cervical region, is directed at first from left to right and backwards, then almost transversely; and finally, directly from above downwards, thus forming the figure of a turned Roman S.

The greater convexity of the thorax corresponds, therefore, anteriorly to the right half, posteriorly to the left half. The right side deviates inwards, the left outwards, and the greatest transverse diameter of the chest bisects the sternum, and answers to the inferior angle of the left scapula.

The following points, observed on the anterior aspect of the thorax, are worthy of remark:—

1. The sternum is wider than in the normal state, and is directed obliquely from above downwards, and from right to left.

2. Of the left ribs, the first alone is articulated to the sternum; the second terminates at the distance of two and a half inches from that bone; the third, fourth, and fifth descend at first almost in a straight line from the hollow of the axilla, and stop at three inches from the sternum; and the others, articulated to one another by a common cartilage, form from left to right a

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medium of some viscid substance to the thoracic parietes immediately over the pulsating body; motion communicated to the feather becomes very apparent at its free extremity, and the interval between two contiguous motions is thus readily recognizable.

[4] The sphygmoscope is a simple instrument thus made: a small glass tube, terminating in a bell, is closed with a tympanum of caoutchouc; a flexible caoutchouc tube, of any required length, is attached to this tube, and in its turn terminates in a small glass tube of two or three inches in length; any coloured fluid contained in this compound tube receives a wave from any pulsating body with which the bell (stopped by the caoutchouc tympanum) is brought into contact. If one sphygmoscope be filled with red fluid, and another with blue, the difference in time of two contiguous pulsating bodies is made very evident, one coloured wave rising in one of the tubes, while the other falls in the next.

Case somewhat similar to M. Groux's.

semilunar arch, and terminate at half an inch from a rudimentary xiphoid appendix.

3. In consequence of this malformation and of the absence of a portion of the ribs, there exists on the left side of the chest a sort of triangle with the base above formed by the first rib and the lower edge of the great pectoral muscle, the truncated apex being directed downwards; at the right superior angle is the nipple; the sides of the triangle are three and a half inches long, its surface is half an inch lower than that of the rest of the chest.

4. In this triangular space are situated the inferior organs of the thorax, covered only by the skin, beneath which the movements of the heart and of a portion of the left lung are distinctly seen.

5. The motions of the heart are observed at the upper angle of the space just described. A movement from left to right is plainly distinguished, and on palpation the impulse of the heart is felt immediately under the skin, appearing reduplicated, and consisting of two shocks, the one longer and stronger, the other shorter and weaker.

The first is isochronous with the systole, the second follows the first and the systole, simulating a weak and rapid rebound.

The motions of the lung are easily recognized by an elevation and depression isochronous with inspiration and expiration, and by the edge of the lung covering the heart gliding alternately from left to right.

6. On percussion it is found that the heart extends from the place where the impulse is perceived to the right under the sternum, and downwards as far as the xiphoid cartilage, and that it has rather a transverse direction from left to right and from before backwards; consequently, it is probable that the part of the heart which pulsates in the triangle corresponds to a portion of the left ventricle.

Moreover, percussion in the upper angle of the triangle yields a clear sound over a circumference of two square inches, which, therefore, covers a part of the left ventricle, and occupies the greatest extent of the triangle; the inferior third furnishes a completely dull sound, and contains the stomach, as well as the left lobe of the liver.

7. Auscultation discloses in the free portion of the heart the two normal sounds, the first being longer, and being emphasized. In the rest of the precordial region the two sounds continue the same, although they are weaker on account of their distance. The accentuation is always laid upon the first, which extends towards the free part of the heart, and corresponds to the stronger impulse already mentioned. The second sound, which is shorter and weaker, corresponds to the second shock, which presents the same characters.

On the contrary, in the region in which, as would appear from

the clear sound yielded on percussion, a portion of the left lung exists, a vesicular murmur alone is heard; in the lower third of the triangle, where the dulness is detected, the ear perceives no sound.

The results of my first examination of M. Groux, made with considerable care, were such as I have stated. At subsequent periods I again examined M. Groux with much attention (I do not here speak of those occasions on which I took part in the investigations and observations made by the Commission of the Royal Irish Academy).

In my subsequent investigations, I found the visible and tactile phenomena very much as already described: but the following results of auscultation were determined by careful exploration of the oval tumour E F with the flexible stethoscope and glass bell, which, as before, we shall denominate "Groux's Stethoscope": Additional observations.

Obs. XXII. On placing the glass bell over the oval tumour with the least possible pressure which was sufficient to maintain contact, a single short and rather faint sound was audible; the same sound was heard when the glass bell was maintained in contact with the tumour by a small quantity of adhesive substance. When an ordinary stethoscope, with a very small bell, was held over the tumour, contact being maintained by the most delicate pressure possible, a similar sound was likewise heard with this instrument; but it required the utmost nicety in the adjustment of the ordinary stethoscope, to obtain the purely single character of the sound. It became apparent to the observer that a very slight amount of pressure was sufficient to replace the single sound which seemed proper to the tumour itself by a well-marked and distinctly double sound, much more loud and intense, and giving the impression that it was derived from a more deeply seated source. This double sound could be, as it were, produced at will; with such pressure over the tumour as was barely sufficient to maintain contact, the stethoscope detected a distinctly single sound of the characters already specified;—a slight amount of pressure brought the instrument in contact with a deeper body having two distinct sounds. This alternation of single and double sound could be produced according as the instrument was placed lightly over the tumour or pressed deeply into the fissure. I dwell upon this point, because, after repeated examination and the exercise of every possible precaution, I can see no ground for doubt- Single faint sound in E F; this sound replaced by double sound if pressure be made. Deeper body with two sounds.

ing its accuracy, though I am aware that the existence of a special single sound, referrable to the oval pulsating body, has been called inquestion by eminent authortiy.

Before we proceed to examine in detail the several phenomena presented in this interesting case, it will be well to consider in the first instance what conditions normal or pathological could be regarded *a priori* as capable of giving rise to the motions and sounds in question. They may be enumerated as follows:—

Conditions capable of producing the phenomena in question.

In the portion of the human chest corresponding to the congenital fissure in M. Groux's sternum we meet with:

I. The Auricles of the Heart (portions of them).
II. The Ventricles of the Heart (portions of them).
III. The Pulmonary Artery.
IV. The Aorta and its Arch.
V. The Arteria Innominata.
VI. The Carotid Arteries (parts of them).
VII. The Superior Vena Cava.
VIII. The Inferior Vena Cava (part of).
IX. Portions of the Lungs.
X. Morbid Conditions, as aneurisms and tumours of other kinds.

It may be observed that our remarks are practically limited in M. Groux's case to the consideration of the phenomena presented by the first five of the causes here enumerated. They comprise, as will be seen, the most essential parts of the central apparatus of the circulation, namely, the four chambers of the heart, and the great vessels which spring from it, and which maintain on the one hand the pulmonic, and on the other, the systemic circulation. For reasons presently to be specified I shall exclude from consideration in this place any phenomena referable to the causes indicated under the ninth head. The Venæ Cavæ in like manner must be regarded as not coming practically within the scope of the observer in the present instance. The Superior Cava it is true, if it retains its normal position in M. Groux's chest, must occupy a position at no very considerable depth in a line corresponding to the posterior surface of the left border of the right half of the sternum. It might be supposed, therefore, that in a fissure such as that presented in M. Groux's case, this vessel could be felt, or that at least some indications of its presence could be detected in the situation above described. After the most careful examination of all parts of the fissure, the most minute and de-

Venæ cavæ practically excluded.

licate tactile exploration of the several parts contained in it, and the most careful auscultation, I am not satisfied that I was at any time able to define a part which I should be warranted in concluding to be the vessel in question. Of its presence in the situation it occupies normally, I see no reason to doubt, while at the same time its movements and sounds, if any, and the physical characters of its walls, are such as not to admit of the vessel being detected by any of the means of exploration now at our command. Superior cavæ not to be detected in fissure.

With respect to the class of causes included under the tenth head, I am persuaded that in the case of M. Groux, there are no tenable grounds for presuming the existence of aneurismal conditions, pulsatile sacs with fluid or semi-fluid contents, receiving a communicated wave from the impact of contiguous vessels, or of other similar morbid states with which we are acquainted. No reason to suppose aneurismal conditions to be present.

This opinion must, it appears to me, be arrived at, from the absence of all signs and symptoms having the characters of those resulting from aneurisms or other tumours, which, of necessity, produce the *extrinsic* phenomena of eccentric pressure and interference with sonoriety.[5] The *intrinsic* phenomena of thoracic tumours may, perhaps, find some parallel in the signs presented by the parts within the fissure; but, as will presently become evident, these (the *intrinsic*) phenomena are fully explicable on the hypothesis that they are caused by the normal action of normal parts; and we thus of necessity eliminate abnormal causes, which no longer require consideration.

We have now narrowed the sphere of our researches to the consideration of the heart and its appendages, the great vessels, pulmonary artery and aorta. Proceeding as we have done, *par voie d'exclusion*, it may be now affirmed that we can recognize no other causes for the phenomena presented in the congenital fissure in M. Groux's sternum, than the four chambers of the heart, and the two great vessels just mentioned, some or all of which it is to be next shown are singly or collectively concerned in the causation of the impulses and sounds in question. It may be as well to remark again, that for Elimination of all causes except the heart and its appendages.

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[5] See a paper by the author on the Diagnosis of Aneurism, Dub. Quarterly Journal of Medicine, May, 1850, in which a *general method* for the Diagnosis of Intrathoracic Tumours is developed.

Motions of Lungs not considered in this section.

the time we exclude from consideration at present the phenomena manifestly referable to the motions of the anterior borders of both lungs, of which more hereafter.

We shall now study in the order in which we have already considered them, the parts presented in the fissure, with the view of assigning to each its special interpretation.

This diagram only a plan

The most prominent and striking phenomena, and those which first arrest the attention of all observers, are the motions and sounds of the oblong or oval body, the axis of the pulsation of which is in the line E F *(see Diagram)*. I have described two motions in this body (Obs. II., p. 456), one slow and apparently reduplicated, in which it comes to the surface: it is obviously the motion of a part being filled with fluid. The other motion is that of a body expelling fluid by contraction of its parietes.

The phenomena presented by this oval body (E F *in Diagram*) must be referred to the action of some one or other of the following causes:—

Possible causes of E F.

I.	The systole and diastole of the		Right Auricle of the heart (Appendix or other portion of it).
II.	"	"	Left Auricle of the heart (its Appendix or other part of it, in some abnormal position of parts).
III.	"	"	Right Ventricle of the heart (portion of it).
IV.	"	"	Left Ventricle of the heart (portion of it in some abnormal position of parts).
V.	"	"	Aorta.
VI.	"	"	Pulmonary Artery.
VII.	"	"	Arteria Innominata.

If we omit IV., I believe it may be said that each of the other causes here specified has been assumed, and its efficiency for the production of the phenomena in question maintained by able observers. In evidence of the diversity of the opinions held on this point and the authority

of their advocates, it will only be necessary to mention the following instances:—

Professor Virchow considers the pulsating body to be the cone of the pulmonary artery. Traube regards it as a part of the right ventricle; by others again it is stated most confidently to be the aorta. Virchow regards E F as cone of pulmonary artery.

Discarding all controversial discussion of the opinions of others, I will proceed to discuss the grounds upon which I conceive the true nature of this pulsating body can be proved by a logical necessity from the several observations we have recorded, and which admit of being verified by all inquirers who devote sufficient time and patience to the investigation. I shall be the more explicit in the adducing of proofs of the nature of this body, as it manifestly and admittedly constitutes the key to the whole series of actions presented in the fissure.

Two observations which can be determined with regard to it with a precision which leaves nothing to be desired, seem to me to closely narrow the circle of admissible causes.

Careful exploration must satisfy the observer that it is a body with comparatively thin and yielding walls: *such is not either ventricle of the heart.* E F is a body with very thin walls.

Under certain conditions it requires an increase of volume, and is thrown prominently forward as a dilated saccular body, to an extent which it is impossible to conceive any portion of the ventricular walls could undergo by any amount of distension: it is equally impossible to conceive that either the pulmonary artery or the aorta could rapidly dilate to the extent observed in the tumour, and as rapidly subside. Its remarkable increase of volume.

The conditions under which this maximum distension of the oval tumour is reached are such as directly affect the right auricle, right ventricle, and pulmonary artery, but in no way affect the aorta, except in so far as probably for the time to diminish the absolute quantity of blood it receives from the ventricle. They are as follows: Pulmonary artery or aorta could not reach the same amount of dilatation.

Obs. XXIII. M. Groux makes a very deep inspiration, and then very slowly and gradually expires until he expels as much air as possible from the lungs. During this latter process, that of forcible expiration, the oval body gradually fills with a succession of waving, more and more rapid, and in the end fluttering irregular motions: in this process it comes prominently forward as a somewhat oval tumour of *at least* three or four times its original volume; Process by which dilatation is effected.

in its state of maximum distension it exhibits a partial subdivision into two portions separated by a slight horizontal depression. These actions are very characteristic of the filling of the right auricle and the distension of it by venous blood by reason of the obstruction offered by the lung, in the condition it is caused to assume during forcible expiration, to the circulation through the pulmonary artery, which reacts upon the right ventricle, and so upon the right auricle. It may be a question whether a dilated state of this part has not been produced artificially by the repeated distension of it in the experiment just described, which, as being one of great interest, M. Groux with his characteristic courtesy exhibits at least twice during every *seance*, though it is attended with not a little personal distress. The series of actions here described is to me conclusive evidence that the tumour in question is a part of the right auricle of the heart, probably (from the cause just specified) an enlarged and dilated appendix. But there are other evidences which, if not individually so striking, are such as, when taken conjointly, to leave no doubt upon my mind of the nature of the principal pulsating body in the fissure; and this point once settled, it becomes as it were the key for the correct interpretation of the remaining phenomena. The impulse (in line E F) of this oval body (right auricle), is not synchronous with that which takes place close beside it in the line H G, nor with that at the point X, nor again with that at the situation of the cardiac apex below the left nipple—(Obs. V. and VII.).

Partial subdivision of E F when in state of maximum distension.

Probable dilatation of auricle in M. Groux.

E F not synchronous with H G or X, or cardiac apex.

The motion H G, visible in favourable conditions of light, and traceable upwards into the neck, is manifestly that of a vessel of large calibre; the upper part of it must be referable to the arteria innominata and the right carotid. The aortic walls cannot, it is true, be as satisfactorily defined in the normal situation of the vessel, as might be supposed *a priori* to be possible; yet, in the absence of any proof of irregular origin or distribution of the vessel, it is not unsafe to presume that it occupies nearly its normal position, though perhaps it is placed somewhat deep.

Nature of motion H G.

The pulsation H G is presumably that of the aorta, and in its upper part certainly that of the innominata and carotid. Now this pulsation is posterior, in point of time, to that of E F (right auricle).

In the normal action of the several portions of the heart,

we know that the systole and diastole of the following parts are severally synchronous in successive pairs:—(*a*), the two Auricles; (*b*), the two Ventricles; (*c*), the Pulmonary Artery and Aorta; and the order of the actions of these parts is that in which they are here enumerated. It is clearly deducible from the foregoing ***that the pulsation* EF *is not that of the Pulmonary Artery;*** if it were, it should and would be synchronous with that of the Aorta and Innominata HG.

Synchronous actions.

E F *cannot be* motion of pulmonary artery.

It will be interesting, I think, to place before the reader at this point one of those brief and luminous passages of Harvey, in which he so well describes the motions of the heart and its several parts. "First of all", observes this great anatomist, "the auricle contracts, and in the course of its contraction, throws the blood (which it contains in ample quantity as the head of the veins, the storehouse and cistern of the blood) into the ventricle, which being filled, the heart raises itself straightway, makes all its fibres tense, contracts the ventricles, and performs a beat, by which beat it immediately sends the blood supplied to it by the auricle into the arteries; the right ventricle sending its charge into the lungs by the vessel (the pulmonary artery), which is called vena arteriosa, but which, in structure and function and all things else, is an artery; the left ventricle sending its charge into the aorta, and through this by the arteries to the body at large".

Harvey's account of action of parts.

The results of my own observations lead me to concur in the accuracy and truthfulness of this description of the order of the cardiac movements, and I cannot conceive by what perverted ingenuity of research, or what desire for the *eclât* of novelty of opinion, it has been recently attempted to substitute another order of actions for that which, since the time of Harvey, has been not alone received on his authority, but confirmed by innumerable vivisections.

No grounds for contrary opinion.

The normal action of parts may then be briefly summed up thus:—Auricles, Ventricles, Aorta, and Pulmonary Artery. But each of these actions is double; each part has a motion of diastole and a motion of systole, and each part has an interval of quiescence or non-action. The synchronism, succession, and dependence of these several actions, may perhaps be thus expressed.

Synchronism and succession of cardiac actions.

A.		B.
I. Auricular diastole,	- -	1. Ventricular repose.
II. Auricular systole,	- -	2. Ventricular diastole.
III. Ventricular diastole,	- -	3. Repose of Aorta and Pulmonary Artery.
IV. Ventricular systole,	- -	4. Diastole of Aorta and Pulmonary Artery.
V. Ventricular repose,	- -	5. Systole of Aorta and Pulmonary Artery, diastole of Auricles.

It must be understood that the several arteries specified in the columns A and B, are not perfectly synchronous[6] in pairs taken one each from opposite and corresponding portions of these scales, as II. with 2, III. with 3, etc. Each element of cardiac action in the column A slightly precedes in point of time the corresponding one in column B.

We have now to arrange under their proper heads the several motions and sounds observable in and near the congenital fissure in M. Groux. We have, on the grounds already specified, determined the oval pulsating tumour EF to be a part of the Right Auricle. It presents a motion of diastole and systole:—the diastole is gradual, and the result of successive actions; the systole is likewise gradual, though a more active movement than the diastole; it is slightly vermicular, which can be appreciated best by the tips of the fingers ranged in line over it. Neither of these actions is one of much force or resistance. As already stated, the systole is attended by a slight but appreciable single sound when the bell of the Groux stethoscope is gently placed over it, such force only being used as is sufficient to maintain apposition (Obs. xxiii. p. 461); if the bell be retained in apposition by any glutinous material, the same result is produced. If the fingers be pressed with even but little force upon the Auricle (oval tumour E F) a distinctly double shock is perceptible to the touch, and with the bell of the Groux or of the ordinary stethoscope, two distinct sounds are audible unless the precaution be adopted, as already explained of using extremely light pressure upon it. As stated (Obs. XXIII.) the single or the double sound is producible

Proofs from sound of E F.

[6] I wish here to draw attention to the uncommon confusion of terms consequent on the erroneous use of the words synchronous and isochronous. The former refers to the simultaneous action of parts moving at the same time, as of pendulums of *equal* or *unequal* length; isochronous signifies the equality of motion in equal times of pendulums of the same length.

at will by graduating the amount of pressure employed with the stethoscope. Single or double sound producible at will.

An obvious and to my mind sufficient explanation of these phenomena is the following:—To the finger and the stethoscope, placed lightly upon the delicate and yielding walls of the Auricle, a single impulse and a single sound, each proper to the Auricle itself, is perceptible. Any increase of pressure causes the yielding walls of the Auricle to recede before the finger or the stethoscope which is then brought into immediate relation with the walls of the *conus arteriosus pulmonalis*, or, as it is otherwise denominated, the *infundibulum* of the right Ventricle, at its junction with the Pulmonary Artery; a portion of this vessel itself is likewise in this situation overlapped by the Auricle, and its motions are felt and heard through the compressed auricular substance when the fingers or stethoscope are made to impinge with any force upon the oval tumour E F.

The observation of Virchow is therefore partially right, for it is undeniable that the cone of the pulmonary artery occupies the position in question; but it is here overlapped by the auricular appendix, the presence of which, as well as its single sound and impulse, would seem to have been overlooked by this usually most accurate observer. Virchow's observations partly right.

We have therefore in the situation of the oval tumour to consider two causes of motion and sound: one superficial and single; the other deeper seated and double. The superficial motions and sounds are those of the Auricle; they are, it is almost needless to repeat, single: the deeper are those of the pulmonary artery. Two distinct causes of motion and sound in situation E F.

An observation of great interest and importance deducible from the foregoing is to be here noticed: The pulmonary artery possesses two distinct impulses and two distinct sounds. Two motions and two sounds in pulmonary artery and aorta.

We have seen that the motions of H G are *presumably* those of the Aorta, and *certainly* in the upper part those of the arteria innominata. It will not be wrong to conclude as follows:—*The Pulmonary Artery and Aorta are shown by the exploration of the congenital fissure in M. Groux to possess a double impulse and a double sound.*

This observation is of great interest, and not without importance and some practical bearing upon the physiological pathology and diagnosis of Aneurisms.

In connection with this important observation, the posi-

tive determination of which we owe to the facility of exploration presented by M. Groux's case, I beg leave to be allowed to cite here some conclusions advanced by me on a former occasion[7] (1850). "The column of blood in the arch and superior part of the thoracic aorta must be considered as subject to two forces acting at an appreciable interval, viz., the ventricular and arterial systoles, the influences of which must be supposed to be combined and simultaneous on particles of blood at a distance from the heart; for in no other way can we explain the single pulsation of the carotid, femoral, and radial arteries".

Author's observations in 1850.

"The sequence of actions may be considered to take place as follows:—The blood contained in the arch of the aorta, receiving an impetus from the left ventricle, is set in motion towards the extremities; but before it can be propelled to any great distance, it receives the additional systole of the first portion of the aorta, and now continues its course impelled by the combined influence of two forces, that of the ventricular systole being as it were overtaken by that of the arterial. It is highly probable that their force becomes thus simultaneous in their action in some part of the descending thoracic aorta, and that the ordinary impulse of the abdominal aorta and its branches, as well as that of the carotid, radial, and femoral, is single". The conjecture was then hazarded, that the impulse in the ascending portion of the aorta was likewise single, except in cases of aneurism. And in the conclusions drawn in this memoir respecting the motion and sounds of aneurism the following observations occur:

"7th. That there is a point, to be yet determined, situated at a certain distance from the centre of the circulation, on the cardiac side of which two impulses and two sounds may in general be expected to attend aneurism, and on the distal side of which these tumours are generally characterized by a single impulse and a single sound; and that on the aortic trunk, the prime point at which the second impulse and second sound are lost, is yet to be ascertained".

These views confirmed by phenomena

We derive from the examination of the motions and sounds presented in the aorta and pulmonary artery in M. Groux's case, an important and direct confirmation of the views suggested in the passages just cited, and which

[7] In *Dublin Quarterly Journal of Medicine*, May, 1850:—Observations on the Motions and Sounds of Aneurism, the mechanism of their production, and their diagnostic value. See also the French translation of this Memoir by M. Aran.

have not, as far as I am aware, been put forward by other observers.[*]

In M. Groux's case.

The next phenomenon of interest is that of the motion at the point X: it is but slightly visible in the perfectly quiescent condition of M. Groux's chest, but on deep inspiration a manifest and vigorous pulsation is seen and felt. It then gives the idea of being caused by the impact on the finger or stethoscope of a body with dense and resisting walls, and acting with considerable force. Its motion is posterior in point of time to that of the auricle E F, and anterior by a slight but appreciable interval to that in the line of the aorta, H G. It is synchronous with that seen and felt below the left nipple, that of the heart's apex-beat.

Motion of point X imperfectly seen in quiescent state.

X posterior in point of time to E F, precedes H G.

There is in my mind no possibility of regarding this movement otherwise than as that of a portion of the right Ventricle: in the position in which it is presented, the character of the movement, and its relation in point of time to the other motions in the cardiac region, and in all other essential particulars, we find that it corresponds with the phenomena of motion and sound which we know to be those of the right ventricle.

X is motion of right ventricle.

The remarkable phenomenon described in Obs. XXIII., p. 465, now demand attention. The extraordinary force of the cardiac pulsations presented when M. Groux performs the respiratory acts described, must, I think, be referred to powerfully increased ventricular contractions, and these I am disposed to regard as chiefly assignable to the Right Ventricle. The auricle dilates to several volumes; the whole heart appears to undergo some change of position, and the pulsations are felt with powerful resistance when the fingers are pressed deeply into the second, third, and fourth intercostal spaces. It would appear as if the heart underwent a kind of rotation, the apex being elevated, and the mass of the dilated right ventricle coming to lie close under the above-named intercostal spaces to the left of the sternum. The mechanism of their action is probably as follows:—

Pulsations in intercostal spaces that of right ventricle.

By the gradual expulsion of the air from the lungs, the pulmonary tissue becomes reduced to a minimum of

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[*] It would be very desirable that the phenomena in M. Groux's case should be submitted to that mathematically accurate recording instrument, the kymographion of Ludwig. I trust, when M. Groux visits Vienna next, he will undergo a careful examination at the hands of my eminent friend, Professor Ludwig.

Mechanism of production of these phenomena: diminished capacity of lungs. Blood accumulates in right ventricle.

capacity. The lungs, in proportion to their diminished volume, become less and less capable of receiving and circulating the mass of blood sent into them at each stroke of the right ventricle. There is then an obstruction momentarily increasing to the passage of the blood through the pulmonary artery; less and less blood is therefore discharged from the ventricle at each contraction: the ventricle, and finally the auricle, become surcharged with blood, constantly pouring into the latter from the vena cava. The auricle becomes dilated and distended; its dilated appendix is that body found in the fissure: the same happens with the ventricle, the force of the pulsations of which momentarily increases in the efforts to overcome the obstruction and discharge the blood with which it is loaded to excess: it is during this over-action of the ventricular walls that the inordinately powerful pulsations are felt in the intercostal spaces.

But a stage is quickly reached beyond which it is not possible that this condition of things can exist; there is a momentary period of almost complete apnæa, after which the muscular tension of the expiratory effort is relaxed, a sudden and deep inspiration takes place, and the normal action of parts is forthwith restored.

Arrest of radial pulse in M. Groux.

A remarkable power of arresting the radial pulse is possessed by M. Groux. This suspension is effected by a series of short and rapid inspiratory efforts, after which the breath is forcibly held. The result is somewhat the same as in the former experiment—distension of the auricle, but not to the same amount. It was repeatedly endeavoured to determine with positive accuracy whether the carotids ceased to beat at the same time with the radials; but owing to the strong action into which the muscles of the neck are thrown in this experiment, it was not easy to determine the matter with certainty. It did seem on some occasions that the carotids ceased to beat for a brief interval. How the act of stopping the radial pulse is effected, must be a matter of speculation. This power is possessed by other individuals.[9] It may be, and probably is effected, in M. Groux's case, by the cone of the lungs' apex on either side being made to press upon the subclavian artery in a direction from below upwards.

Do carotids cease to beat as well as radials?

[9] It is almost unnecessary to say that the mode of stopping the pulse at the wrist, alluded to here, is not that in which the arm is forcibly retracted, and the subclavian artery strained against the first rib.

Voluntary power possessed by M. Groux over lungs and respiratory motions.

Amongst the most remarkable instances of the voluntary powers which M. Groux has acquired over the action of certain parts are those alluded to already, by which a reduction of the pulmonary tissue to a minimum capacity for air and blood is effected. This condition has been already sufficiently noticed. Another effect is that of withdrawing the anterior borders of the lungs, to the extent on the left side of effecting the removal of the pulmonary structure totally from in front of the heart. This likewise has been already sufficiently studied. A third effect (less remarkable in my opinion) is that of protruding the anterior borders of the lungs in the fissure: this is accomplished at will on either side, but apparently to a greater extent on the right than on the left. On the right side an irregularly globular or oblong mass is caused to protrude from beneath the right half the sternum: it gives the usual percussion sounds of pulmonary substance, and of its nature there can be no doubt. I will take this opportunity to observe, that after careful consideration of the phenomena in question referable to the voluntary movements of retraction and extrusion of the pulmonary substance, I cannot see that they offer any basis whatever for speculations bearing upon the mode of connection of the emphysema of the lung: and having said so much, I shall abandon this subject, which, it appears to me, has been made the ground of much unprofitable discussion.

Protrusion of lungs in fissure.

No conclusions admissible as to connection of emphysema.

While M. Groux has acquired voluntary power over lungs, he possesses none over cardiac movements.

It is somewhat singular, and the observation is one fraught with great interest, that while M. Groux has acquired a certain amount of voluntary power over the movements of the lungs, he seems to be quite incapable by any effort of the will of interfering with the movements of the heart. True it is, he can distend the auricle in the manner already described, and he can likewise arrest the pulsation of the radial arteries; *but both those effects, it is to be remembered, are brought about indirectly by the agency of the lungs.* M. Groux, then, seems to want entirely that direct voluntary power over the heart's movements, said to have been occasionally manifested in the human subject, as in the celebrated case of Colonel Townsend.

Any such *apparent* power is indirect and referable to lung

I shall now sum up seriatim, by way of conclusions and corollaries, the results which I think have been gained to science and to practical medicine from the minute study of the phenomena presented in M. Groux's case.

Conclusions.

I. It appears to me that we have gained by the study of M. Groux's case much precise knowledge of the force, vigour, and general importance of the motions and sounds of the Right Auricle of the heart, and, presumably by analogy, of both auricles of the heart in the state of health. It is to be concluded that the motion of the auricles of the heart in the human subject are forcible, vigorous, and independent, in point of time, of other contiguous motions.

Our knowledge of the auricular motions extended

Cor. A.—Without going into detailed discussion of the applications of this knowledge of the motions and sounds of the Auricles to questions in practical medicine, I will state briefly such important deductions as present themselves to me.

The motions of the Right Auricle of the heart, and presumably of the left in conjunction with it, are in themselves sufficient to account for certain of the hitherto unexplained pathological phenomena of cardiac action in the disease known as Pericarditis.

Light thrown on certain phenomena of pericarditis.

(*a*) The single friction murmur over the site of the Auricle, often observed in acute Pericarditis, may be referred to the systole or contraction of the Right Auricle. (*b*) One of the two friction sounds audible, in ordinary cases of Pericarditis, is attributable to the systole of the auricles; the *first* friction murmur is in ordinary cases that which we may attribute to the auricular systole. (*c*) A certain roughness of tone, sometimes, but not always, amounting to murmur, will be found in certain cases to attend the cardiac action: it may be referred, in some instances at least, to a state of the auricular surface which has been at one period coated with lymph, the result of partial or localised pericarditis; cure has been effected without adhesion of the opposed surfaces; the lymph remains unabsorbed, and though in progress of time it becomes covered over with serous epithelium, an amount of irregularity of surface remains capable of giving roughness to the cardiac sounds. The systole of the Auricle is under these circumstances attended with a slight but distinct, rough, attrition murmur.[10] Cases of this kind are liable to be mistaken for acute pericarditis, and the highest stethoscopic skill is requisite to insure a safe diagnosis.

First friction murmur attributable to auricular contraction.

Certain rough cardiac sounds explained.

II. The systole of the Auricle is attended by a sound of a faint but distinctly appreciable character. This sound,

[10] These observations are based on specimens (illustrating well the conditions now described, for the first time, I believe) preserved in my collection in the Museum of the Catholic University Medical School.

it may be supposed, is, under the ordinary healthy conditions, not sufficiently loud to be propagated with distinctness through the sternum. (It requires, it must be remembered, the nicest and most delicate adjustment of the stethoscope to detect it when the instrument is placed on the auricle with only the integument intervening, in the case of M. Groux.)

Sound of auricular systole not propagated through sternum in ordinary conditions.

Cor. B.—Certain cases of duplicate conditions of the first sound of the heart may be explained by supposing the auricular sound (sound of the auricular systole) to become intensified to such a degree as to be audible through the sternum.

Certain duplicate sounds explained.

III. The Pulmonary Artery and the Aorta (*i.e.*, a vessel of large size occupying the position of this latter vessel, and presumably the great primary arterial trunk) present each a double impulse and a double sound in the healthy condition.

Double impulse and double sound in pulmonary artery and aorta in healthy condition.

Cor. C.—(*a*) The double sound of the great vessels, if we suppose it to be augmented and intensified, will explain those duplicate and even triplicate conditions of the second sound, audible in the cardiac region under certain circumstances. (*b*) The double impulse and double sound of the Aorta throw much light on the phenomena commonly presented in aneurisms within the thorax. These tumours are, we know, generally attended by two distinct impulses and two distinct sounds; those of the abdomen are usually characterized by single impulse and single sound.

Certain duplicate conditions of second sound explained.

Light thrown on phenomena of aneurism.

In connection with this point, I beg leave again to refer the reader to the extracts from my memoir of the year 1850, already given.

IV. (*a*) The ordinary succession of cardiac actions is as follows in point of time (as originally laid down by Harvey):—1stly, the systole of the Auricles; 2ndly, the systole of the Ventricles; 3rdly, the systole of the great vessels (Aorta and Pulmonary Artery).

Normal succession of cardiac actions that laid down by Harvey.

(*b*) The (right) auricular contractions become, under certain conditions of dilatation of the auricle, weak, fluttering, and irregular

Cor. D.—We derive from these phenomena an explanation of the weak, fluttering action of the heart sometimes observed during life.

Cor. E.—The phenomena presented in the right chambers of the heart, when the capacity of the lungs is diminished, have a direct and important bearing on the similar states of dilated right heart produced by chronic pulmonary disease.

ART. VI.—*On the function of Sömmering's Yellow Spot in producing unity of visual perception in binocular vision.* By THOMAS HAYDEN, M.D.

THE simplest form of visual organ with which we are acquainted is exemplified in the eye-dots of the common leech; they are ten in number, and disposed in the form of a semicircle in front of the mouth, in the concavity of the oral disc. These eye-dots are dark specks of microscopic dimensions, consisting of a convex transparent cornea, beneath which is placed a layer of dark pigment, representing the choroid, but destitute of iris and pupil, and behind this the bulbous enlargement of the optic nerve. This rudimentary eye is therefore unprovided with an optical or refracting apparatus, and is consequently incapable of more than a vague perception, by which it is enabled to distinguish light from darkness. Indeed the position of the eyes in this and allied animals, on the inferior surface of the organs of progression, where they are shut off from any but the most indirect and general influence of light, would render it impossible they could enjoy a more elevated order of vision. It is, however, amply sufficient for their purposes, and is supplemented by the very acute sense of touch which they possess.

A grade of vision but slightly elevated above that of the leech and star-fish is enjoyed by most insects and crustaceans. Though apparently much more complex in structure, the eye of these animals is really nothing more than the multiple of an organ scarcely more elevated in the scale of organization than that just described. The compound eye of the crab (Cancer) or the butterfly (Papilio), consists of a number of hexagonal corneæ, extended in form of the section of a hollow sphere; each cornea is bi-convex, and separated from those adjoining by superficial grooves, so that the surface of the eye presents the appearance of a beautiful mosaic pavement. Behind the cornea is placed a conical vitreous body, extended in the direction of the radius of the eye, and surrounded by a dark choroid, except in front, where an aperture is left corresponding to the pupil, and behind, where its small extremity is received into the cup-shaped expansion of the "proper optic nerve"; the latter is prolonged backwards in the radius of the eye, perforating the "common choroid", and expanding to form the "common retina", both of which are semicircular and concentric with the superficial surface of the eye.

From the common retina the "secondary optic nerves" extend backwards in the same direction for a short distance to the bulbous enlargement of the "primary optic nerve", which itself is derived from the supra-æsophagal ganglion, corresponding to the brain in higher animals. Each of these hexagonal eye-tubes is thus constituted an independent *ocellus*, associated with the others only by a common dependence on the primary optic nerve. The superficial area of its larger extremity, or that presented to the surface of the eye, varies in the different orders of the Articulata. The number of ocelli likewise varies for the different orders, but is determinate in each order of a class; thus, in the common house-fly (Musca domestica) of the order Diptera, the number is 4,000; in the dragonfly (Libellula), order Neuroptera, about 12,000; in the butterfly (Papilio), order Lepidoptera, 17,355.

The peculiar construction of the organ just described, would appear to be supplemental of the immobility of the head and eyes, and also of the want of an apparatus for optical adjustment. The eye being immovably fixed in its position, and the head comparatively so, an extensive range of vision could be acquired only by conferring upon the eye such a degree of convexity and prominence as would enable it to command a view of objects placed before and around it; but a simple refractile organ of this form, and incapable of altering the direction of its axis, would obviously be attended with the inconvenience of spherical aberration in an exaggerated degree. To obviate this inconvenience, and render vision as distinct as the circumstances will admit, the eye is divided into a number of radiating cones, having separate and independent functions, and so directed that the rays of light reaching the eye from an object situated anywhere within the field of vision, must fall upon one or more of them in the direction of its proper axis; and as each is encased in a dark choroid, and not more than the fraction of a line in its transverse diameter, the marginal portion of the entering pencil of rays, or all those which deviate from the axis, must impinge upon the sides of the tube, and be there absorbed; the consequence is, that the axial ray alone finds entrance, and as this suffers no refraction in its passage, spherical aberration cannot occur. A further advantage is gained by an eye of this construction in the power which it confers upon the animal of seeing the most minute objects with the utmost distinctness; for any object which subtends the produced axes of two adjacent ocelli, will be depicted upon the retina as distinctly as one of much larger size.

It is obvious, likewise, that rays of light reaching the eye from any distance within the field of vision, will find a sufficient number of ocelli suitably directed to receive and transmit them

in the line of their axes; and as none but axial rays can reach the retina, all others being arrested in their progress, distance can have no influence in modifying the definition of the object, save only as to the vividness of the impression, and hence aberration from parallax can have no existence, and an apparatus for adjustment is not required.

In man and vertebrate animals generally the eye is constructed upon one and the same model, and possesses essentially the same parts variously modified according to the medium in which the animal lives, and to some extent also the peculiar habits to which it is addicted. The mechanical principle held in view appears to be that of the camera obscura. The constituent parts of the organ may be conveniently divided into the essential and the tributary; the former include the refractile media, namely, the cornea, aqueous humour, crystalline lens, and vitreous body, together with the retina or percipient membrane; the latter, the sclerotic coat and choroid, with its appendages—the ciliary ligament, ciliary body, ciliary muscle, and iris, besides the proper rotatory muscles and common elements of organization, viz., vessels and nerves.

The figure of the eye is, in itself, of but secondary importance, and entirely determined by that of the refractile media in the aggregate; and as the latter affect a spheroid for optical reasons sufficiently obvious, the eye assumes a corresponding form within certain limits. The limitation alluded to may be expressed by the formula—the greater the sphericity of the lens, and the shorter its consequent focal length, the less is the antero-posterior diameter of the eye-ball. But as the total magnitude of the vitreous body, which occupies four-fifths of the hollow sphere, must bear a certain fixed proportion to that of the lens for the purpose of optical adjustment, it follows that the eye must gain in the transverse what it loses in the antero-posterior axis. Hence, in fishes, whose lens is a perfect sphere, the eye is flattened considerably in the direction from before backwards, and in mammalia and birds it is more globular, whilst the lens is less spherical than in fishes. In man the figure of the eye-ball and crystalline lens is in strict accordance with the principle above laid down. The axis of the former is about .98 inch, and its vertical diameter .90 inch.[1] The excess of the antero-posterior over the vertical diameter is due to the presence of the cornea in front, which, being a segment of a smaller sphere, having a radius of 3.3 lines[2] appended to the larger, represented by the eye-ball,

[1] Valentin's Physiology, by Brinton, p. 430.

[2] Sömmering de oculorum hominis animalium que sectione horizontali commentatio. Göttingæ, 1818.

increases the antero-posterior diameter by about .4 inch, and renders the eye spheroidal. The axis of the lens measures 1.6 line, its transverse diameter, 3.6, radius of anterior convexity, 4.2, of posterior convexity, 2.4 lines.[3] Thus the eye of man presents a configuration the reverse of that which characterises the organ in mammals, birds, and fishes. The convexity of the lens is to a certain extent supplemental of that of the cornea and aqueous humour taken together. In fish, the aqueous humour is small in quantity, because its refractive index being scarcely higher than that of the water in which the animal lives,[4] such a fluid could serve no useful purpose as a refracting medium; it is therefore present in quantity barely sufficient to float and sustain the iris; and as the cornea has a degree of convexity corresponding to the quantity of the aqueous humour, it is in this class of animals nearly flat: hence the remarkable convexity of the crystalline lens. The eye of the bird affords an exception to this rule, namely, a convex cornea, an abundant aqueous humour, and a spheroidal lens. The rarity of the medium in which high-flying birds occasionally exercise the faculty of vision, as well as the distance at which they view objects whilst soaring in the higher regions of the atmosphere, require that every refractile agency of which the eye is capable should be placed at the animal's disposal for these occasions. But as the birds under consideration, in common with those of less exalted flight, ordinarily move in the lower and more dense strata of the atmosphere, the provision just mentioned must not be fixed and immutable, but rather capable of such modification at the will of the animal, as may adapt it to the special circumstances under which it is brought into operation. The ciliary muscle, which in birds is of the striated or voluntary kind, supplies the means of effecting the necessary change, by regulating the degree of convexity of the cornea, and altering the position of the crystalline lens.

A further provision for adapting the eye of the bird to vision at various distances, is supplied in the circle of bony plates imbedded in that portion of the sclerotic which immediately surrounds the cornea; for when, under the compressing action of the oblique muscles which embrace it like a girdle, the eye is elongated from behind forwards, the protrusion of its anterior surface is limited to the cornea by the unyielding nature of the osseous circle immediately adjoining, hence a greater convexity of the cornea, and a proportionately increased refraction of the rays of light transmitted through it.

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[3] Sömmering, *opus citat.*

[4] Refractive index of aqueous humour, 1.337; do. of water, 1.336.

With the exceptions presented by man and the Quadrumana amongst mammals, and the strigidæ (owl-family) amongst birds, the eye occupies a position on the head more or less lateral in all animals. The eye-dots of Annelida and the "simple eyes" of insects and crustaceans will, of course, constitute additional exceptions; but the former being rudimentary and anomalous in so many particulars besides that of position, and the latter, when placed centrally on the head, being supernumerary organs, need not to be admitted as invalidating the rule just stated. In consequence of the lateral position of the eyes the visual axes diverge in front when the eye is in *equilibrium*, and in the majority of animals do not admit of being brought to a focus, however much they may be produced anteriorly, as is shown in *fig.* 1 (annexed), and *fig.* 2 (p. 481), which represent the relative position and direction of the eyes in man and the ox. It is obvious that animals so endowed are incapable of perceiving a single object with both eyes simultaneously, in the lines of their visual axes, and as it will be shown subsequently that the convergence of the axes of vision upon an object, constitutes an indispensable condition for the single perception of it with two eyes, it follows that the great bulk of the animal creation, and probably the entire animal kingdom with the exceptions formerly mentioned, are destitute of this the highest attribute of the faculty of vision.

In the bottom of the human eye, at a distance of about one-eighth of an inch outside and a little above the point of entrance of the optic nerve, and nearly in the axis of vision, a yellow spot is observable in the retina, as represented at A in the diagram *fig.* 3. This spot, which is about $\frac{1}{24}$ inch in diameter, was first described by Sömmering, and named by him the "foramen centrale", from the circumstance that a minute aperture is visible in it, and that it occupies a central position in the eye; over it the vesicular constituent of the retina alone is expanded, the fibrous and vascular elements diverging as if to avoid it.[4] The yellow spot of Sömmering is peculiar to man and the monkey tribe, and forms a zoological feature quite distinctive of the orders Bimana and Quadrumana; it therefore coincides with the frontal po-

Fig. 3

A, yellow spot of Sömmering.
B, entrance of optic nerve with central artery of retina.

[4] Todd and Bowman, the Physiological Anatomy and Physiology of Man, part iii. p. 31.

sition of the eyes, and the faculty of single vision with a double organ equally characteristic of these two orders, and may not unreasonably be supposed to be inseparably related to, and indispensable to the existence of, this faculty, according to the rule in physiology of inferring functional from structural peculiarity. Whether anything resembling the yellow spot exists in the eyes of nocturnal birds I have not been able to determine, not having had an opportunity of examining the organ in one of these animals whilst engaged in preparing the present article.

From the arguments now stated, supported by experiments to be detailed further on, I have been led to the conclusion that unity of visual perception with two eyes is inseparably associated with the yellow spot of Sömmering, and may invariably be inferred from its presence, and that this property is limited to a circle, having as its centre the foramen centrale, and a radius of about ·04 inch. This circle I propose to designate as the "region of visual unity", within which the rays of light proceeding from an object must fall, in order to produce a single perception from a binocular impression. Outside this circle, and concentric with it, is another, having a radius of 0·533 inch:—the latter I would name the "region of visual duality", because I believe that the image of an object depicted within it, and outside the region of unity in both eyes simultaneously, produces a double perception in the sensorium. That portion of the retina extending from the region of duality to the *ora serrata* or free border, is probably insensible to luminous impressions, and serves some other purpose in the economy of the eye, with which we are still unacquainted. Diagram *fig.* 4 (p. 483), modified from Valentin, will render the preceding observations more intelligible. It represents a section of a graduated sphere, which may be assumed, for the purpose of illustration, to exhibit a magnified view of the eye.

First experiment.—If the optic axis $l\,k\,i$ be directed to an object situated at 90°, the object will be depicted on the yellow spot at l, and will be seen with its *maximum* of distinctness. If now the eye be slowly rotated upon its centre, k, to either side, the object, being stationary, will continue to be seen with undiminished distinctness till the axis pass 87° or 93°, as the case may be. During this rotatory movement of the eye, the image of the object travels *pari passu* in the same direction (or rather, the image remains stationary whilst the retina moves), from l to o or l to p, through the retinal angle $l\,k\,o$ or $l\,k\,p$; *i.e.*, over a space measured by the radius of the circle of "visual unity". If the eye still continue to rotate in the same direction, the perception of the object grows gradually less distinct till the axis reach 50° or

Fg. 4.

130°, when it has attained its *minimum* of distinctness, and beyond that point it ceases to be visible.

In the last-mentioned portion of the experiment the image of the object moves through the retinal angle $p\,k\,n$ or $o\,k\,m$, and therefore through a space corresponding to the radius of the circle of "visual duality" *minus* that of the circle of visual unity. If now, instead of a single eye, both be used in this experiment, and the produced optic axes convergent upon an object situated in the common axis be moved 3° towards the visual base,[*] the image of the object will move in both eyes through the segment of a circle $l\,o$, and produce but a *single* perception in the sensorium. If, while the position of the object remains unaltered, the axes still continue to move in the same direction, till they intersect in a point in the common axis 37° nearer the visual base, the images of the object will travel through segments $o\,m$, and produce a *double* sensorial impression.

Second experiment.—If three small bodies be placed at a, b, and c (*figure* 5)

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[*] The terms "visual base" and "common axis" were first used by Dr. Wells (An Essay upon single vision with two eyes, by W. C. Wells, M.D., London, 1818), the former to designate a horizontal line connecting the optic axes at their points of emergence from the corneæ, and the latter a line passing forward from the middle of the visual base through the point of mutual intersection of the optic axes.

Fig. 5.

in the common axis P C B A, at short distances apart, and about ten inches from the face, and the optic axes *l f n* B and *i g o* B then brought to bear upon the central body at B, whilst the visual angles B *e n* and B *d* C, or B *e* A and B *d* A, are made to include either the more or the less distant one at A or C, the body at the point of intersection of the optic axes in B will be seen single, whilst the included body at A or C will appear double. If now the axial and included bodies be slowly approximated, the two images of the latter will be observed to gradually approach each other, till ultimately they are converted into one, when the bodies have attained a certain close proximity.

If, on the contrary, the bodies be separated to a greater distance from one another, the two images of the included body will be likewise separated in a corresponding ratio till they are entirely lost sight of. If, whilst the bodies occupy their original position, one eye be suddenly closed, we lose sight of one of the images of the included body, the one lost being that of the *op-*

posite side, when the body which yields it is the proximal one, and that of the *same* side when that body is the distal one.

In this experiment, the object situated at the intersection of the optic axes produces but a single visual perception, because the image of it is depicted on the retina of each eye within the circle of visual unity at *b* and *i*, whilst the included body gives rise to a double perception, because the rays of light proceeding from it are incident upon the retinæ at *j* and *k* or *h* and *m*, outside that circle, and within the region of visual duality. When, however, the included is made slowly to approach the axial body, it will arrive at a point ere it come into contact with the latter, at which it produces but a single perception, because, during this movement, the retinal angle, decreasing in an equal ratio with the visual angle, will come finally to be less than 3°, and therefore to fall within the circle of visual unity. The abolition of one of the two images of the included body, consequent upon the closing of either eye, is due to the fact that its apparent position is advanced or retracted, as the case may be, towards the visual curve described by the optic axis as a radius. When the body included in the visual angle is the proximal one at C, its images are projected to opposite sides of the common axis P C B A, towards the visual curves described by the radii *i* B and *l* B, but encountering in their course thither the axial rays B *n f l* and B *o g i* proceeding from the object at B, they are arrested at *n* and *o*, where the lines of their visible direction intersect those rays. Hence the closure of the right eye is attended with the loss of the *left* image at *n*, and of the left eye with that of the *right* image at *o*. When, on the contrary, the included body is the distal one at A, its images are retracted quite to the visual curves described by the radii *i* B and *l* B, because the lines of their visible direction meet no interruption from the axial rays B *n f i* and B *o g i;* and since the altered position of the image is on the same side of the common axis as the eye which takes cognizance of it, the closure of the right eye in this case involves a loss of the *right* image, and that of the left eye a loss of the *left* image. The apparent change of position of the included object in this experiment, is probably the result of ocular adjustment; it is impossible that the eye can adapt itself at one and the same time to the vision of two objects placed at different distances from it; and as only one of these can be in the optic axes, and the length of the axial ray determines the adjustment of the eye, the apparent position of the other is altered by the actual state of adjustment, for the purpose, as it would seem, of equalizing its distance to the length of the axial ray.

Third experiment.—If we look through two small tubes so

held before the eyes that the optic axes shall traverse them as nearly as possible in parallel lines, we see two luminous circles of exit. If, now, the tubes and axes be made slowly to converge towards a common point in front, we come at length to see but a single circle. If, over each orifice a slip of coloured glass be placed as in the experiment of Dutours, one being yellow and the other blue, a single luminous circle will be seen as before; but this will not be of the intermediate colour, green, the two colours being superposed, not blended, and a portion of each visible at the same time. In the first part of this experiment two luminous discs are seen, because the optic axes normally converge in front, and under no circumstances, as I believe, diverge, or even assume the mutual relation of parallel lines, in the healthy eye: hence the rays of light admitted through divergent or parallel tubes intersect the axes at angles more or less acute, and if the latter exceed .04 and are less than .533 inch, the rays fall on the retina within the region of visual duality, and give rise to a double perception of the orifice. With reference to the non-fusion of the colours, the explanation I am disposed to offer is, that the course of the optic axes being interrupted by the coloured glass before reaching the point of mutual intersection, the colour placed in each makes an unmixed impression on the corresponding retina, and this impression being uninterrupted preserves its individuality, although the apparent situation of the glass which produces it is projected to the "plane of the horopter", *i.e.*, a plane at right angles to that of the optic axes, and passing through the point of their mutual intersection; here the coloured discs are accordingly seen to overlap without being blended. In the familiar experiment of rapidly rotating before the eyes a disc painted in the seven colours of the solar spectrum, the compound *white* is produced, because the impression made by each primitive colour, though transitory, is of sufficient duration to last till those of the complemental colours are superadded.

The advantages conferred by the use of two eyes in viewing objects, conjoined with the faculty of forming a single conception from a double image, are:

Firstly, as shown by Jurin,[7] objects seen with both eyes appear brighter than when viewed with one, by about one-thirteenth part.

Secondly, the individual is thereby enabled to judge of distance through the muscular sense exercised in the movements of the eyes, whilst directing their axes towards the object to be viewed, as observed by Sir C. Bell;[8] for, although in monocular vision the

[7] Smith's Optics, vol. ii. p. 107, *et sequent.*
[8] Philosophical Transactions, 1823, p. 178.

operation of directing the axis of one eye to near and distant objects requires an equal degree of muscular contraction, and a proportionate exercise of the muscular sense in the muscles brought into action, as when both eyes are used, still an equally certain means is not thereby afforded by which to judge of distance; because, whilst a single eye is being used in viewing an object placed in the common axis, a change in the position of the object towards the right or left side would require a contraction of the rectus muscle of the same side, for the purpose of altering the direction of the axis, differing only in degree from that necessary when the object is brought closer to the eye, or removed to a greater distance from it; and hence a lateral change of position in the object might be readily mistaken for one in the line of the common axis. This source of error is obviated by the use of both eyes, which enables us to distinguish between the changes of position indicated; for if the object move from the mesial line towards either side, the external rectus muscle of one eye and the internal rectus of the other are called into consentaneous action, whilst a movement towards, or from the face, in the direction of the common axis, would be followed by a contraction of the internal or external recti of both eyes, as the case might be.

It is worthy of remark, as bearing on this subject, that the internal and external recti are supplied with nerve-filaments from distinct sources, namely, the third and sixth cerebral nerves. If it be admitted that the muscular sense is an endowment conferred upon muscle by its nerve of supply, the exercise of that sense through distinct nervous channels, in the two cases supposed in the last paragraph, will obviously serve as a means of distinguishing between them. As the distance of the object from the eye must regulate the angle formed by the visual axes convergent upon it, the intuitive knowledge which we possess of the magnitude of this angle, by what Porterfield aptly terms "the natural geometry of the eyes", must serve as a means of approximately determining distance. When, however, but one eye is made use of, we have only two sides of the triangle, namely, one axis and the visual base, by which to measure the angle under which the object is viewed, which, being insufficient for that purpose, we necessarily fail in the attempt to determine distance by this means. Inasmuch, however, as the angle in question diminishes less sensibly for very distant objects, we are unable to determine with equal accuracy the distance, and consequently the magnitude, of objects so situated.

Thirdly, the capacity of forming a single conception from a double image confers the further advantage of enabling the

individual to appreciate figures projected in relief, as shown by the ingenious experiment of Wheatstone.[9]

Of the various theories that have been propounded, in explanation of the phenomenon of single perception from dual vision, I will direct attention to those three only which have commanded the greatest amount of respect, both by their ingenuity, and the deservedly high character of their authors. Sir Isaac Newton[10] asks the question:

"Are not the species of objects seen with both eyes united, where the optic nerves meet before they come into the brain, the fibres on the right side of both nerves uniting there, and, after union, going thence into the brain in the nerve which is on the right side of the head; and the fibres on the left side of both nerves uniting in the same place, and, after union, going into the brain in the nerve which is on the left side of the head; and these two nerves meeting in the brain in such manner that their fibres make but one entire species or picture, half of which on the right side of the *sensorium* comes from the right side of both eyes, through the right side of both optic nerves, to the place where the nerves meet, and from thence on the right side of the head into the brain; and the other half, on the left side of the *sensorium*, comes in like manner from the left side of both eyes.

"The optic nerves of such animals as look the same way with both eyes (as of men, sheep, dogs, oxen, etc.) meet before they come into the brain; but the optic nerves of such animals as do not look the same way with both eyes (as of fishes and the cameleon) do not meet".

This explanation, though simple and apparently satisfactory at first sight, will not stand the test of close inquiry; an opinion which appears to have been shared by its great author, from the circumstance of his having offered it in an interrogative form. It proves too much and too little for the intended purpose. When an object is viewed with both eyes, it is not the *half* of a single image which is depicted on the corresponding sides of the two retinæ, as stated by Newton, but the *whole;* and if this be not his meaning, but rather that the half of *a double* image—*i.e.*, the whole of a single one—is portrayed on each retina, then the original difficulty remains untouched.

Again, if an object, placed directly before the face in the common axis, be not of such dimensions as to occupy a space greater than the interval between the optic axes at the points of their emergence from the corneæ—if, in short, it be a mere point, it will obviously not be depicted upon "the right side of both eyes", and thence propagate an impression to the *sensorium* "through the right side of both optic nerves", nor "upon the

[9] Philosophical Transactions, 1838, part ii. p. 371, *et sequent.*
[10] Newton's Optics, query 15.

left side of both eyes", and thence to the *sensorium* "through the left side of both optic nerves", nor indeed upon any points whatever of the retinæ, save those corresponding to the optic axes or their immediate vicinity, unless the axes intersect before reaching the object, in which case a double perception would be the result, as shown by the second experiment.

Nor does the anatomy of the optic chiasma, on which Newton relied for confirmation of his theory, afford it more than a negative support, for although in no animal, as far as we know, capable of viewing an object with both eyes simultaneously, is there an absence of an optic commissure, still in many whose eyes have a decidedly lateral aspect, and are therefore incapable of axial convergence, it exists in a not less perfect state than in the former. This is the case in most of the whale tribe, and in birds generally.

The opinion of Müller[11] on this subject will appear from the following quotation:—

> "Parts of the retina which lie in the same segments of the sphere, in the same meridian and the same parallel of latitude, the middle point of the retina being regarded as the pole, or which lie at equal distances in the same direction from the centre of the retina, are completely identical. All other parts of the retina are non-identical, and when they are excited to action the effect is the same as if the impressions were made on different parts of the same retina. If the position of the eyes with regard to a luminous object be such that similar images of the same object fall on identical parts of the two retinæ, the object cannot be seen otherwise than single; but in any other case two images must be seen".

This theory of "identical" and "non-identical" parts affords a satisfactory explanation of many of the phenomena of vision, but not of all. In the second experiment it has been shown that if two bodies placed in the common axis be brought into such close proximity, that whilst one of them is in the optic axes, the lines of visible direction of the other shall intersect those axes at a retinal angle of less than 3°, the latter will produce but a single perception in the *sensorium*, although its image is depicted on the *inner*, or the *outer* side of the axis, *i.e.*, on non-identical parts of both retinæ.

The last theory I shall notice is probably the most beautiful that has been offered on this subject, and, though insufficient in itself to meet all the requirements of the case, is nevertheless, in its measure, a satisfactory explanation, namely, that of Aguilonius,[12] as adopted and modified by Porterfield. The

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[11] Müller's Physiology, by Bayly, vol. ii. p. 119.
[12] Aquilonii Optica, as quoted by Wells, *opus citat.*

theory of Aguilonius may be stated thus:—All bodies seen at a glance *appear* situated in the plane of the horopter; if *really* situated in that plane, they appear single when viewed with both eyes; if *not really* situated in it, they appear double; because, if situated behind the plane of the horopter, their lines of visible direction intersect each other before reaching that point of it in which they appear situated, and, if in front of that plane, they appear likewise double, because their lines of visible direction pass through it at different points before intersection.

Porterfield writes:[13]—

"In seeing objects, the mind, by means of an original and connate law, to which it has always been subjected, traces back its own perceptions not only from the sensorium to the retina, but from thence also outwards towards the object itself, along right lines drawn perpendicularly to the retina, from every point of it on which any impression is made by the rays forming the picture, by which means the mind or visive faculty does always see every point of the object, not in the sensorium or retina, but without the eye, in these perpendicular lines".

These two theories combined afford a rational explanation of single vision from a double image, and of double vision from a single object, notwithstanding the sneer of Sir C. Bell,[14] but they do not assign to the retina its due influence in these phenomena, much less attribute to special portions of it special functions, which it has been the purpose of this article to establish, and without admitting which, I hold it to be impossible to account for many visual phenomena, as, for example, the fusion of the two images of the included body which results from approximating it to the axial body, as in the second experiment.

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[13] A Treatise on the Eye Edinburgh, 1759, vol. i. p. 372.

[14] Philosophical Transactions, *loco citat.*

SCIENTIFIC NOTICES.

PHYSICS.

1.—*The Rev. Dr. Lloyd on the Direct Magnetic Influence of a Distant Luminary upon the Diurnal Variations of the Magnetic Force at the Earth's Surface.*

The diurnal changes of terrestrial magnetic force, which exhibit phænomena inexplicable by the theory of thermo-electric currents, have led Dr. Lloyd to examine the influence which might be ascribed to the sun and moon, on the hypothesis that these bodies are endowed with inherent or induced magnetism.

Having found analytical expressions for the three rectangular components of the magnetic forces upon any point at the earth's surface, Dr. Lloyd resolves these components in the direction of the earth's radius and in the tangent to the meridian, and thus finds, for the variations of U and V, the horizontal and vertical components of the earth's magnetic force, the equations

$$\Delta U=\frac{1}{D^3}\Big\{\sin\theta\,(2P\sin\delta+Q\sin\lambda\cos\delta)+\cos\theta\,(2P\sin\lambda\cos\delta-Q\sin\delta)-R\cos\lambda\cos\delta\Big\}$$

and

$$\Delta V=\frac{1}{D^3}\Big\{(2P\cos\theta+Q\sin\theta)\cos\lambda+R\sin\lambda\Big\}$$

where D represents the distance of either luminary from the centre of the earth, λ the latitude of the point on the earth's surface, θ the angle included between its meridian and that of the magnetic luminary, and the magnetic declination, P, Q, and R, the sums of the components of the magnetic forces in the direction of the rectangular axes.

At the equator where $\lambda=0$, we have

$$\Delta U=\frac{1}{D_3}\Big\{\sin\delta\,(2P\sin\theta-Q\cos\theta)-R\cos\delta\Big\},$$

$$\Delta V=\frac{1}{D^3}(2P\cos\theta+Q\sin\theta).$$

Hence it would follow, that a diurnal inequality having one maximum and one minimum, should take place in the magnetic intensity depending on θ, or in other words, on the hour angle of the sun or moon. The actual phenomena are, however, entirely opposed to this. Hence the author concludes, that the phenomena of diurnal variation are not caused by the *direct magnetic action* of the sun and moon. This inquiry is valuable in so far as it seems to remove from the theory of terrestrial magnetism, a supposition which might otherwise stand in the way of the true path of investigation.—*Proceedings of the Royal Irish Academy, February*, 1858, *and Phil. Mag. for March*, 1858.

2.—*On the best Unit of Length.*

This inquiry is developed in a group of systematic replies by Mr. James Yates, to a series of questions circulated by the International Association as to the determination of a unit of length best adapted to the present wants of mankind. The result of the whole inquiry is an overwhelming mass of the clearest evidence in favour of the metre, and the conclusions have been embodied in a report which has been unanimously adopted by the Association.

Mr. Yates has taken pains to show the great difficulty with which the question of improved weights and measures had so long to contend in England, in spite of the exertions of intelligent and energetic advocates. Amongst others he says—" None deserves more honourable mention than Sir John Riggs Miller, an Irish baronet, who, in order that he might collect information and promote reform, sat in parliament for one of the lowest of the rotten boroughs, received more than a thousand letters, obtained the appointment of a committee to investigate the actual state of the weights and measures used throughout England, and exposed their faults in two speeches, more clear, powerful, and conclusive than any others upon the subject. His efforts were abruptly terminated by the dissolution of parliament, so that England remains in the same disgraceful condition which he so eloquently and ably exposed".

Mr. Yates shows clearly that the hair-splitting objections against the metre arising from its presumed want of accuracy as an exact representation of the ten-millioneth of a quadrant of the meridian, are altogether devoid of any practical application. He points out its superiority as a standard, over its competitor, the length of the second's pendulum, and shows that it is susceptible of being applied advantageously by its subdivisions and multiples to all purposes in the arts and in trade where exact measurements are desirable. Besides showing the progress which its application is making in foreign countries, he shows that even in England it has already obtained a footing partly among men of science, and partly among manufacturers and traders, whose operations are connected

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[1] What is the best unit of length?—An inquiry addressed to the International Association for obtaining a uniform decimal system of measures, weights, and coins. London: Bell and Daldy.

with those of foreign countries. From the postscript to Mr. Yates' treatise, we learn the very important fact, that in Russia the metre is also coming into use, not only amongst scientific circles, but also among different classes of artificers and tradesmen.

CHEMISTRY.

3.—*Investigation of Croton Oil.* By Dr. Thom. Schlippe.

The author has published the results of what appears to be a very thorough investigation upon this subject. We can only give his summary of results here, referring to the memoir itself for details :—

(1.) In the preparation of croton oil, spirit of wine acts rather as an expelling agent than as a solvent, because the ordinary rancid oil requires 23 parts, and the pure fat oil 35 parts of spirit of wine of 85 per cent. to dissolve them.

(2.) The oil obtained by means of spirit of wine is a stronger irritant than that got by pressure.

(3.) The acids forming the fat oil of croton oil are:—

a Of the homologous series, having the general formula $C_{2n}H_{2n}O_4$:— Stearic acid, $C_{36}H_{36}O_4$; Palmitic acid, $C_{32}H_{32}O_4$; Myristic acid, $C_{28}H_{28}O_4$; and Lauric acid, $C_{24}H_{24}O_4$.

b Of the Oleic acid homologous series, probably some members between $C_{20}H_{18}O_4$ and $C_{34}H_{32}O_4$; besides these, Crotonic acid of the formula $C_8H_6O_4$ and Angelic acid, $C_{10}H_8O_4$.

(4.) All the acids named under 3 are contained in the non-rancid oil, as glycerides.

(5.) Crotonic acid is neither an irritating agent when applied externally, nor a drastic when used internally.

(6.) The irritating agent of croton oil is a resinous body, crotonol, whose formula is either $C_{18}H_{14}O_4$, or a multiple of it.

(7.) The often observed peculiar smell of non-rancid croton oil, and which greatly resembles the decoction of senega root, arises from a product of decomposition of crotonol. Another product of decomposition is the volatile oil of former investigators.

(8.) The material which, in croton oil, reddens the skin, or crotonol, has no purgative action; the latter property belongs to another body which has not been isolated.—*Annalen der Chemie und Pharmacie, neue Reihe Bd.* xxv. *Heft.* 1. *S.* 1.

4.—*On the formation of Succinic Acid during alcoholic fermentation.* By M. Pasteur.

The author states that during the alcoholic fermentation of sugar, part of it is transformed into succinic acid, whose amount is at least one-half per cent. of the fermented sugar. The simplest process to separate the suc-

cinic acid is to evaporate the fermented liquor, and dissolve out the acid with ether; if it be accompanied with so much lactic acid that its crystallization is thereby hindered, the two acids should be saturated with lime, and the salts separated by weak alcohol, in which lactate of lime is soluble and succinate of lime insoluble. Pasteur also detected the presence of succinic acid in wine.—*Comptes rendu*, xlvi. 179.

5.—*Note on Hesse's Experiments on Products of Putrefaction of Beer Yeast, and on the Probability that some of the Compound Ureas are usually Present in Common Urea.* By WILLIAM K. SULLIVAN.

Since the publication of my paper in the first number of this journal—"Observations on some of the Products of the Putrefaction of Vegetable and Animal Substances and their Relation to Pathology", p. 202,—I have learned that Professor Hesse has been likewise studying the same subject, and has arrived at results almost identical with mine. He has published an account of his experiments on the products of the putrefaction of beer yeast in the *Journal für Praktische Chemie*, No. 16, 1857. The acids he found were acetic, propionic, butyric, caprylic, and pelargonic. He is of opinion that formic acid was also present. The bases, besides ammonia, were trimethylamine, monethylamine, monamylamine, and one whose composition agreed with that of monaocprylamine, but whose crystalline form appeared to indicate that it was a different substance. The platinum salt of some other base was also obtained, but no definite results as to its constitution could be found. He does not mention the presence of valeric acid, which is singular, considering that amylamine was formed, and that amylic alcohol is a constant product of fermentation. I have invariably found it present in the products of putrefaction of all the substances, whether vegetable or animal, that I have examined.

In connection with this subject, I may be pardoned for mentioning here what I had quite forgotten when writing the article above mentioned, namely, that I had read a short paper before the Pathological Society of Dublin in the beginning of 1850, upon the products of the putrefaction of brain, in which I announced that, in addition to a base having the properties possessed by trimethylamine, I obtained one in which one equivalent of hydrogen was replaced by $C_{10}\ H_{11}$, the supposed radical valyle, or in other words the base, now called monamylamine. The only published record of this fact which I can lay hands upon at the moment, is a note in a Review by Dr. Lyons, on the Pathology of the Kidney, in the *Dublin Quarterly Journal of Medical Science*, p. 388, No. XVIII., May, 1850, and which I shall give here:—

"Some interesting observations on the new ammonias were laid before the Dublin Pathological Society at one of its recent meetings, by Mr. William K. Sullivan, chemist to the Museum of Irish Industry, etc. Mr. Sullivan has observed that in the breaking up of the constituents of the brain during the process of putrefaction, a large quantity of valerianic acid is produced and at the same time ammonia, but an ammonia, in which part of the hydrogen is replaced by a carbo-hydrogen: in this instance valyle, the carbo-hydrogen of valerianic

acid, was the one which had been substituted. Mr. Sullivan is further of opinion that such bodies may occur in the animal organism also, and that their ureas (that is, combinations having the same relations to these ammonias that common urea has to the ordinary ammonia) will be found of frequent occurrence in abnormal conditions of the blood and urine".

It is gratifying to find that so important a fact as the formation during putrefaction of compound ammonias, and even of one not otherwise known at the time, should be so completely verified by so competent an observer as Professor Hesse.

Before passing from this subject I may also observe that Dr. Odling of London has mentioned to me, that he had found Amine bases in exhalations from sewers.

The circumstance of having read the paper to the Pathological Society was accidentally recalled to my memory in reading a notice in Liebig's and Kopp's *Jahresbericht* for 1856, of the interesting discovery of Dessaignes of trimethylamine in human urine. In consequence of the peculiar smell of the carbonate of ammonia evolved during the evaporation of urine, he submitted large quantities to distillation. The distillate, smelling strongly of ammonia and of sea fish, became red on being supersaturated with hydrochloric acid; on evaporation a quantity of salammoniac first separated. The mother-liquor was evaporated to dryness, the dried mass exhausted with alcohol, and the solution treated with bichloride of platinum, by which, after several crystallizations, beautiful crystals of the double salt of hydrochlorate of trimethylamine with chloride of platinum were obtained. Its composition was verified by analysis. Sixty-five litres of fluid obtained by distillation from urine already concentrated gave 2,200 grm. of chloride of ammonium and only 17 grm. of the platinum double salt, equivalent to 3.7 grm. of trimethylamine. In the notice alluded to (p. 524) it is observed that Dessaignes left it undetermined whether the trimethylamine existed ready formed in the urine, or appeared in it as a product of decomposition. Now I think the suggestion contained in the note above quoted from the *Dublin Quarterly Journal of Medical Science*, with regard to the probable formation of compound ureas in the animal body, points to its true source. Common urea in solution in urine decomposes, producing carbonic acid and ammonia, $C_2H_4N_2O_2+2HO=2CO_2+NH_3$. Under the same circumstances, trimethylurea, if it be formed in the body, would give trimethylamine. Thus:

$$\underbrace{C_8H_{10}N_2O_2}_{\text{Tremethylurea.}}+2\,HO=2\,CO_2+NH_3+\underbrace{NC_6H_9}_{\text{Trimethylamine.}}$$

It is impossible to overrate the importance in a physiological, as also in a pathological, point of view of this question of the probable formation in the body of compound ureas, now especially that Dessaignes' observation places it almost beyond doubt. This must plead my excuse for referring to my observations of eight years ago, and which, I regret, have been allowed to lie so long barren. Now that our knowledge of the compound ammonias and compound ureas is so complete, it is to be hoped that physiologists will seek for these bodies in urine, etc. The chemistry of that fluid is evidently not yet exhausted.

COMPARATIVE ANATOMY, PHYSIOLOGY, ETC.

6.—*On the penetration of the Spermatozoa into the Ovum during the act of fecundation.* By P. J. Van Beneden.

One of the most interesting questions in this branch of physiology is that which affects the part played by the spermatozoa in the process of fecundation. Van Beneden has given the results of some observations made on the *Distoma* from the stomach of the turbot. An ovum just formed was placed under observation; it presented in the centre a transparent vesicle covered with opaque granulations. Around this vesicle were to be seen numerous little transparent spheres without any appearance of granulations.

While the attention was fixed on the germinal vesicle, it was seen to be suddenly disturbed, and around the vitelline mass a delicate filament was perceived, having an undulating movement. This was the spermatozoön, which was still alive, and had manifestly penetrated within the vitelline mass. This spermatic filament was about double the length of the ovum, and surrounded the vitelline mass so as nearly to form a complete ring. At the end of an hour all motion ceased in the spermatozoön.

Van Beneden concludes from his observations—

(1.) That the spermatozoön is in immediate contact with the germinal vesicle and vitelline mass.

(2.) That the spermatozoön disappears without leaving any trace of its passage.

(3.) That no vitelline membrane exists at the first period of the life of the ovum.

(4.) That these ova have no occasion for a *micropyle*, since the spermatozoön is present before the formation of the envelopes.—*Bulletin de L'Academie Royale des Sciences, etc., de Belgique, Tome* 4, *No.* 4, *p.* 312, 1858.

END OF VOLUME I.

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AMERICA.

From the Franklin Institute.

1. Journal of the Franklin Institute of the State of Pennsylvania. Third Series. Vol. xxvi., No. 6. Vol. xxvii, Nos. 1, 2, 3, 5. *Philadelphia*, 1859.

2. Report of the Twenty-Sixth Exhibition of American Manufactures, held in the City of Philadelphia from October 15th to November 13th, 1858, by the Franklin Institute of Philadelphia.

From the Canadian Institute.

3. The Canadian Journal of Industry, Science, and Art, conducted by the Editing Committee of the Canadian Institute. Nos. 18, 19, 20. *Toronto.*

AUSTRIA.

From the Imperial Geological Institute, Vienna.

4. Jahrbuch der kaiserlich-königlichen Geologischen Reichsanstalt. For the years 1850, 1851, 1852, 1854, 1855. Nos. 1. 2, 3, for 1857 (No. 4 completing the volume already received). Nos. 1 and 2 for 1858.

From the Imperial Geographical Society, Vienna.

5. Mittheilungen der k. k. geographischen Gesellschaft. Redigirt von Franz Foetterle. I. Jahrgang, Hefte 1 and 2, 1857; II. Jahrgang, Hefte 1, 2, 3, 1858; III. Jahrgang, Heft 1, 1859.

BELGIUM.

From the Royal Academy of Sciences, Brussels.

6. Bulletin de l'Académie Royale des Sciences des Lettres et des Beaux-Arts de Belgique. T. 5, Nos. 11, 12. T. 6, No. 1, 2, 3, 4.

7. Annuaire de l'Académie Royale. 1859.

From the Royal Academy of Medicine, Brussels.

8. Bulletin de l'Académie Royale de Medécine de Belgique. T. ii., 1, 2, 3, 4. 5, 6. 7. Session of 1848–1859.

From the Editors.

9. Revue de l'Instruction Publique en Belgique, T. ii., Nos. 1, 2, 3, 4, 5.

10. Journal Historique et Littéraire. T. xxv., Livr. 10, 11, 12. Vol. xxvi., Livr. 1, 2.

BAVARIA.

From the Royal Academy of Munich.

11. Gelehrte Anzeigen, herausgegeben von Mitgliedern der königl. bayer, Akademie der Wissenschaften. Vols. 45, 46, and 47.

From Professor Lamont, Director of the Royal Observatory of Munich.

12. Astronomische Beobachtungen angestellt auf der königl. Sternwarte zu Bogenhausen bei München von J. Soldner. Bds. i., ii., iii., iv., v., enthaltend die Beobachtungen von 1820–1827.

Observaciones Astronomicæ in Specula regia monachiensi institutæ, et Regio jussu publicis impensis editæ a J. Lamont. Vol. vi., vii., viii., ix., x., xi., xii., xiii., xiv., xv. Seu novæ sereiei. Vol. i., ii., iii., iv., v., vi., vii., viii., ix., x. Observationes annis, 1828, 1829, 1830, 1831, 1832, 1833, 1834, 1835, 1836, 1837, 1838, 1839, 1840, 1841, 1842, 1843, et 1844, factas continens.

(The two series form a complete collection in 15 volumes).

13. Annalen der königlichen Sternwarte bei München. Vol. i. to x., from 1848 to 1858 (being the continuation of the Observaciones Astronomicæ, and also of the Annalen für Meteorologie und Erdmagnetismus).

14. Annalen für Meteorologie und Erdmagnetismus. Heft. 1—12. 1842 to 1854.

15. Jahresbericht der münchener Sternwarte für 1852 und 1854.

16. Astronomischer Kalender für das Königreich Bayern auf das gemeine Jahr, 1850. Do., 1851; do., 1852; do., 1853. *München.*

17. Resultate des Magnetischen Observatoriums in München während der dreijährigen Periode, 1843–1845. Von Dr. J. Lamont. *München*, 1846.

18. Bestimmung der horizontal Intensität des Erdmagnetismus nach absolutem Maase. Von Dr. J. Lamont. *München*, 1842.

19. Magnetische Ortsbestimmungen an verschiedenen Puncten des Königreichs Bayern und an einigen auswartigen Stationen.

I. Theil—mit 18 lithographirten Tafeln
II. " " 26 " "
Beilage—Lamont's Magnetische Karten von Deutschland und Bayern.

20. Untersuchungen über die Richtung und Stärke des Erdmagnetismus an verschiedenen Puncten des Südwestlichen Europa im allerhöchsten Auftrage seiner Majestät des Königs Maximilian II. von Bayern. Ausgeführt von Dr. J. Lamont, Professor an der Ludwig—Maximilian's Universität und Conservator der königlichen Sternwarte. *München*, 1858.

21. Beobachtungen des meteorologischen Observatoriums auf dem Hohenpeissenberg von 1792—1850.

Meteorologische Beobachtungen aufgezeichnet an der königl. Sternwarte bei München in den Jahren, 1825—1837. Erster und Zweiter Supplement Bände zu den Annalen der münchener Sternwarte.

22. Verzeichniss der vorzüglichsten im Königreiche Bayern gemessenen Höhenpunkte nebst den geographischen Positionen der grösseren Städte, etc., von Dr. J. Lamont. 2te vermehrte und verbesserte Auflage.

23. Beschreibung der an der münchener Sternwarte zu den Beobachtungen verwendeten neuen Instrumente und Apparate. Von Dr. J. Lamont. *München*, 1851

24. Nebula Orionis ex Observationibus in Specula Monachiensi institutis a J. Lamont.

25. Stellarum Acervus in Clypeo Sobieskii ex Observationibus in Specula Monachiensi institutis a J. Lamont.

From the Author.

26. Sawitri, eine Indische Dichtung aus dem Sanskrit übersetzt von Joseph Merkel, Professor und Hofbibliothekar *Aschaffenburg.*

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ENGLAND.

From the Literary and Philosophical Society of Manchester.

30. Memoirs of the Literary and Philosophical Society of Manchester. Vol. xv., p. 1. Proceedings of the Society from October 6th, 1857, to April 20th, 1858.

From the Statistical Society of London.

31. Journal of the Statistical Society of London. Vol. xxii., parts 1 and 2 for March and June, 1859.

From the Society of Arts, London.

32. Journal of the Society of Arts. *Regularly received.*

From the Geological Society of London.

33. Abstracts of the Proceedings of the Geological Society of London. *Regularly received.*

FRANCE.

From the Imperial Zoological Society of Acclimatation, Paris.

34. Bulletin mensuel de la Société Impériale Zoologique d'Acclimatation. T. v. No. 12. T. vi. Nos. 1, 2, 3 4, 5.

From the Imperial Academy of Dijon.

35. Mémoires de l'Académie Impériale des Sciences, Arts, et Belles-Lettres de Dijon, 2me. Série. Tom. 1, 2, 3, 4, 5, 6. for the years 1851 to 1857, with an Atlas—Description d'un nouveau genre d'E'dente fossile, renfermant plusieurs espices voisines du Glyptodon. Illustrative of a memoir of M. L. Nodot.

From the Editors.

36. Revue Générale de l'Architecture et des Travaux Publics. Journal des Architectes, des Archéologues, des Ingénieurs, et des Entrepreneurs. Publié sous la direction de M. César Daly, 19me. année, 16 Vol. Nos. 7, 8, 9, 10, 11, 12. (Completing the volume.)

37. Journal de l'Agriculture Pratique. Publié sous la direction de M. J. A. Barral. Année, 1859. Tom. i., Nos. 2, 3, 4, 5, 6, 7, 8, 9.

38. Cosmos. Rédigée par M. l'Abbe Moigno. Vol. xiii., No. 26. Vol. xiv., No. 1 to 24.

39. Nouvelles Annales de Mathématiques. No. for October, 1858. Completing volume for that year.

40. Annales de Philosophie Chrétienne; ivme. série. T. xviii., Nos. 107, 108. Tom. xix., 109, 110, 111.

HESSE DARMSTADT.

From the Editors.

41. Annalen der Chemie und Pharmacie. Hrsg. von F. Wöhler, J. Liebig, u. H. Kopp. Nos. 9, 10, 11, 12, for 1858.

LOMBARDO-VENETIAN KINGDOM.

From the Institute of Venice.

42. Atto dell' imp. reg. Istituto Veneto di Scienze, Lettere ed Arti, dal November, 1858, all' Ottobre, 1859. Tome Quarto Serie Terza; Dispense 1°, 2°, 3°, 4°, 5°, 6°.

From the Editor.

43. Annali di Chimica applicata alla Medicina. Nol. xxvii., fasc. 6.

NAPLES AND SICILY.

From the Academy of Catania.

44. Giornale del Gabinetto Letterario dell' Accademia Gioenia. Vol. 4°. Fasc. 1 and 2.

PONTIFICAL STATES.

45. La Civiltà Cattolica. ccviii., ccix., ccx. Serie iv., vol. i., Quaderni, 216, 217, 218, 219, 220, 221, 222.

PRUSSIA.

From the Geological Society of Germany

46. Zeitschrift der deutschen geologischen Gesellschaft. Bd. x. H. 2, 3.

From the Archæological Society of Berlin.

47. Ueber die Anthesterien und das Verhältniss des attischen Dionysos zum Koradienst. Von Hrn. Gerhard. *(Gelesen in der Akademie der Wissenschaften am 1ten. Juli, 1858.)*

48. Das Grab des Dionysos an der Marmorbasis zu Dresden—Achtzehntes Programm zum Winckelmansfest der Archäologischen Gesellschaft zu Berlin. Von Carl Bœtticher.

From the Editor.

49. Archiv für Pathologische Anatomie und für Klinische Medicin. Hrsg. von R. Virchow,

14ten. Bd. H. 3-4, 5-6 (completing volume).

15ten. Bd. H. 1-2, 3-4, 5-6 (completing volume.)

RUSSIA.

From the Esthonian Literary Society at Dorpat.

50. Verhandlungen der gelehrten estnischen Gesellschaft zu Dorpat. 3ter. Band. 1st. Heft. 4ter. Band. 1ter. u. 2ter. Heften.

SWITZERLAND.

From the Swiss Association of Science.

51. Verhandlungen der Algemeinen Schweizerischen Gesellschaft für die gesammten Naturwissenschaften bei ihrer Versammlung in Trogen am 17, 18, und 19 August, 1857.

From La Société Vaudoise des Sciences Naturelles, Lausanne.

52. Bulletin de la Société Vaudoise des Sciences Naturelles. T. vi., No. 43.

Catalogue de la Bibliotheque, *Lausanne*, 1858.

MISCELLANEOUS BOOKS, PAMPHLETS, ETC.

From the Authors.

53. A Paper on the Subject of Burns' Pistols, read at a meeting of the Society of Scottish Antiquaries, on Tuesday, 19th April, 1859. By the Right Rev. Bishop Gillis. *Edinburgh.*

54. Canadian Ballads and Occasional Verses. By Thomas D'Arcy McGce, M.P.P. *Montreal*, John Lovell, 1558.

55. The Mutinies and the People, or Statements of Native Fidelity, exhibited during the Outbreak of 1857-1858. By a Hindu. *Calcutta*, 1859.

J F. Fowler, 3 Crow Street and 24 Temple Lane, Dublin.

CATHOLIC UNIVERSITY OF IRELAND.

The Catholic University of Ireland, though brought into existence by the accidental circumstances of the day, really owes its foundation to the reasonableness or even necessity of the principle, that a country, possessed of intellectual and moral characteristics proper to itself, should not be without some great central School, for the development of the national genius and the expression of the national mind, according to those elementary laws of opinion and sentiment, which belong to it in history and by inheritance. As England glories in her own Universities, as being institutions cognate to her peculiar social temperament, and uses them as abodes and as organs of her peculiar nationalism, so it is natural that Ireland too should require some corresponding seat of mental activity, and its establishment, when once she began to think and act for herself, was only a matter of time.

Passing over the historical circumstances of its origin, not as unimportant, but as unnecessary and irrelevant to the present sketch, let it suffice to say that collections were commenced in behalf of the Catholic University of Ireland under the authority of the Bishops in the year 1851, and that Professors were appointed in three of its Faculties, and its Schools opened, in the autumn of 1854. It is now commencing its fourth year, and, though its organization is still incomplete, and its classes have not reached their full development, its success hitherto has surpassed the expectations of even zealous supporters, and it has the promise of a steady progress and a satisfactory consolidation in the years which are now before us.

It embraces the five Faculties of Theology, Law, Medicine, Philosophy and Letters, and Science; of which the three latter are at present actually set up and in operation.

I. The Faculty of Theology is not as yet in full operation. A beginning has however been made. A double course of lectures, in Theology and Canon Law alternately, has been commenced, and will be continued to the end of the Session.

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There are seven Professors in the Faculty of Medicine; sixteen in that of Philosophy and Letters; and six in that of Science. Deducting those Professors who belong to more Faculties than one, and those who are extraordinary, the whole number of Professors in work in the three Faculties above mentioned, is nineteen.

II. The Faculty of Medicine is established in the large Medical House in Cecilia Street, which contains under its roof two theatres, dissecting rooms, rooms for anatomical preparations, and a chemical laboratory.

This laboratory has been fitted up upon the plan of those established in connection with several of the German Universities, and is designed to meet the wants of three classes of students: 1. those who propose to study chemistry for purely scientific purposes, among which may be named chemico-physiological investigations; 2. those who require a knowledge of chemistry for practical purposes, as agriculture, mining, metallurgy, the various chemical manufactures—bleaching, dyeing, tanning, brewing, distilling, sugar-boiling, paper-making, etc., and civil engineering; 3. students of medicine, who are required to attend one or more courses of lectures on practical chemistry during the summer months.

The course of instruction will be adapted to the objects which each class of students may have in view. Considerable facilities will be afforded to those who intend to devote themselves to industrial pursuits, of acquiring a thorough knowledge of the processes employed in analyzing manures, ores, alloys, salts, barks, dye stuffs, pigments, pharmaceutical preparations, etc.

Besides the regular University lectures on chemistry, the syllabus of which is given in the programme of the Faculty of Science, and which are common to the students of the Faculties of Science and Medicine, and open to auditors on payment of the usual fees, special lectures will be given from time to time, on such branches of chemical science as may appear to be necessary to meet the requirements of particular laboratory students, and which are not comprised in the regular University courses.

With the view of affording students of medicine, etc., an opportunity of acquiring a knowledge of practical pharmacy, a very complete steam apparatus, including vacuum pan, steam engine, etc., constructed by Mr. J. A. Coffey, of London, has been fitted up. This apparatus will also afford facilities for showing the various new applications of steam in the arts, and the manipulation of the vacuum pan in sugar-boiling, etc., etc.

The laboratory is open for students on every day of the week during the session, Saturdays and academical holidays excepted.

The fees for laboratory instruction, which include the cost of all apparatus and materials,—platinum and silver vessels, and salts of gold, silver, platinum, etc., excepted,—must necessarily depend upon the kind and amount of instruction required.

Although it is recommended to students who propose to work in the laboratory, to enter at the commencement of the academic session, they may do so at any other period.

The Medical Faculty is also in possession of the celebrated Munich Library.

This library is the result of the united collections made since an early period of the last century, by some eminent medical philosophers of Germany. It has been most recently enriched by the additions of Dr. von Ringseis, Rector of the University of Munich, from whose hands it has passed directly into the possession of the Catholic University of Ireland. It comprises over 5,000 volumes, including some of the richest and most *recherché* works in medical literature, from the earliest periods of printing. It may be said to represent the select medical literature of the chief schools which have flourished in Europe. The languages which it comprises are Greek, Latin, French, German, Dutch, Italian, and English.

It has also a Medical Lodging House attached to it, in No. 41 York Street, presided over by one of the University Anatomical Demonstrators, and containing accommodation for such students as are willing to avail themselves of it. The terms of board and lodging in this House are £30 for the academic year of nine months.

The Fees of the Medical School are as follows:—

Qualified Matriculated Students, Free; Non-Matriculated Students, £2 2s. for each course.

At the termination of the Session Public Examinations will be held, when, in addition to the usual Prizes in each class, Three Gold Medals will be awarded for the best answering in the following combined subjects:—

1. Anatomy, Physiology, and Chemistry.
2. Surgery and Practice of Medicine.
3. Chemistry, Materia Medica, and Medical Jurisprudence.

The Examination consists of three parts—Written, *Viva Voce*, Practical, or Demonstrative.

The Certificates issued for attendance on Lectures at this

School are fully recognized and received by the King and Queen's College of Physicians in Ireland, the Colleges of Surgeons of Dublin, London, and Edinburgh, the Queen's University in Ireland, the Universities of London, Glasgow, Aberdeen, and St. Andrew's, the Faculty of Glasgow, the Army, Navy, and East India Medical Boards, and by the Apothecaries' Halls, Dublin and London.

III. The Faculty of Philosophy and Letters holds its schools in the University House at No. 86 Stephen's Green. Here too is the University Library, which was commenced with the books of the late Most Rev. Dr. Murray, and has been increased by the valuable library left by the Very Rev. Dr. Flanagan, late P.P. of St. Nicholas, by the library of Mr. Valentine Delany, and by the splendid donations of Mr. Hope Scott, and of other friends of the University.

In the present year its Professors are lecturing or will lecture on Aristotle's Rhetoric, Thucydides, Sophocles, the Cyropædia, Horace, Logic and Metaphysics, Public Law, the History of the Early Church, the Antiquities of Egypt and Palestine, Modern History, English History and Literature, Modern Languages, Algebra, Euclid, and Conic Sections.

In conjunction with the Faculty of Science it prepares young men for the examinations necessary for the Army, the Artillery, the Civil Services, and for the Profession of Civil Engineering.

Special Courses of Lectures, two years in length, are arranged for such Students as are desirous of qualifying themselves for these Examinations.

IV. The Course of Studies prescribed by the Faculty of Science is the subject of a separate Advertisement.

V. It is proposed to establish an Observatory, for the twofold object of advancing science by systematic researches, and of affording to the senior students in the faculty of science ample opportunities for becoming acquainted with the methods generally practised in the sciences of exact observation.

VI. It is also proposed to form a University Museum, comprising: i. A collection illustrative of general natural history. ii. A mineralogical collection, consisting of: 1. Series of known mineral species; 2. Series illustrative of form, including pseudomorphs, etc.; 3. Series illustrative of structure. iii. A geological collection, consisting of: 1. A series illustrative of the nature and structure of rocks; 2. A palæontological collection, or series of

fossil organic remains. iv. Collection of models and materials in connection with civil engineering and architecture. v. An art collection, which will include statuary, painting, engravings, carvings in wood, ivory, etc., cameos, seals, niello, enamels, fictile manufactures, mediæval church and other artistically wrought textile fabrics. vi. An ethnological collection, consisting of the weapons, implements of chase, domestic utensils, dress, etc., of the various barbaric or semi-civilized nations, especially those connected with Irish missionary enterprise.

No suitable building has yet been provided for such collections, but a nucleus has already been formed, which it is hoped will be rapidly enlarged. This nucleus consists of a donation by the late Monsignore Bettachini, of the Oratory of St. Philip Neri, Bishop of Jaffna, of a great number of specimens of the birds, amphibiæ, and recent shells of Ceylon; and an extremely interesting collection of Greek *terra cotta* vases, etc., found in making some excavations in the neighbourhood of Athens by Major Patterson, and presented by him to the University; a small but choice collection of minerals, rocks, etc., obtained by purchase.

VII. The University Church in Stephen's Green is used for the University High Mass and Sermon, for the Senate, for the Distribution of Prizes, for the Theological Disputations, and other formal University acts. Room is provided for the accommodation of strangers, it being capable of holding 900 or 1000 persons.

On the first of January, 1857, the Students in Lecture in these three Faculties amounted to 110.

VIII. The Burses, Exhibitions, and Prizes, given to the students, are as follows:—

1. Ten Burses for two years, of £40 a-year each, for students in Philosophy and Letters, who are destined at the end of that time to enter the Schools of Medicine, or of any other Faculty in this University; the presentation being in the hands of the Bishops.

2. Two Exhibitions of £35 a-year each, to last two years, for classical and mathematical proficiency respectively, open to the competition of students who have passed their first examination, which takes place at the end of two years' standing.

3. Two Exhibitions of £25 a-year each, to last two years, for classical and mathematical proficiency respectively, open to the competition of students who are not of two years' standing.

4. Seven Prizes of £5 each, offered year by year to the competition of students under four years' standing, five of them for literary compositions in prose or verse, and two of them for acquaintance with some mathematical work or subject.

5. Medical Prizes as above.

6. A Prize of books given to the best students at each of the Affiliated Schools after the annual examination.

7. A free Burse for four years, offered once a-year to the competition of students belonging to the Affiliated Schools.

IX. There are at present four Collegiate Houses in the University for the accommodation of students; St. Patrick's, St. Mary's, St. Laurence's, and our Lady's of Mount Carmel. The Pension varies with the Houses and the students. At St. Patrick's it is £60 the Session, which includes all expenses except the entrance and examination fees of £1 each. The only extras, which a student need have in addition, are the cost of books, clothes, and medicine.

The Collegiate Houses are governed by a Dean, who lives in the House and is the Chaplain. He avails himself of the assistance of Sub-Dean, and Tutor or Tutors, intern or extern, as he judges it expedient. The aid of Private Tutorial Instruction, in addition to Professorial Lectures, is included in the Pension. This aid is best given, when possible, by an Intern Tutor, whose office answers generally to that of a Private Tutor at Oxford and Cambridge, or of a German Professor or Doctor who takes private pupils. It is the office of the Tutor to prepare his Pupils for the Professorial Lectures and the successive Examinations; and, as he has to act, not as their superior, but as their friend, he has no coercive jurisdiction over them.

X. 1. Such Students as are inmates of the Collegiate Houses are the formal Intern members of the University; but there are two other classes of persons who are considered practically as Interns, and have the same privileges as Interns.

2. First, those who, though boarding and sleeping at home, enter themselves at some Collegiate House, and place themselves under its jurisdiction during the business hours of the day, that is, from nine or ten o'clock to three. These Students have, among other privileges, the full Tutorial instruction of Interns.

3. Secondly, those who are members merely of a Licensed House; the conditions of a Licensed House being, that its responsible Holder is a member of the University, and that its Discipline is not more stringent than that to which proper Externs are submitted. The Medical Lodging House, mentioned above, is one of these Licensed Houses.

4. These are the two classes of quasi-Interns. As to Externs proper, they are such students as lodge at home or in an approved Lodging, and have nothing found for them (as board, tuition, etc.) by the University.

5. Auditors are such as, without being entered, or passing the Examinations, attend the Lectures of the University.

6. Non-residents are such as, without attending the Lectures of the University, are entered and pass the Examinations.

Thus there are six different methods, of more or less intimate connexion with the University. 1. That of Interns, living in Collegiate Houses. 2. Interns, attending Collegiate Houses. 3. Interns, living in Licensed Houses. 4. Externs. 5. Auditors. 6. Non-residents. To which may be added, 7. Auditors and Non-residents who are in the same position as Externs, except that they are beyond University jurisdiction.

TABLE OF FEES

(For first year; succeeding years are either the same or less).

	Collegiate House. £	Professors' Money. £	Entrance Fee. £	Total. £
Interns proper, in Collegiate Houses, .	50	10	1	61
Interns improper, with use of Tutor,				
1. Attached to Collegiate Houses,	10	10	1	21
2. In Licensed Houses, *e. g.*, Medical Lodging Houses,				
Externs proper, ...	0	10	5	15
Auditors, ...	0	10	0	10
Non-residents, . .	Fees of Membership and Examination.			

XI. The Intern's day is made up of attendance at Mass, attendance at Lectures, recreation, preparation of Lectures, etc. He must be indoors in the evening at a fixed hour.

The Extern must be indoors at ten at night. He attends the University High Mass, and observes his religious duties, as the Intern.

XII. Affiliated Schools are such Grammar Schools through the country as are subject to the yearly inspection of the University. The pupils are examined, and, as is mentioned above, are rewarded by Prizes at school, and by Burses in the University.

XIII. The grades or ranks in the University are those of Student, Scholar, Inceptor, Licentiate, and Doctor or Fellow of the University. Of these the real dignities or degrees are the Scholarship, Licentiate, and Doctorate.

The members of the University are examined:—1. At Entrance, when they become "Students"; 2. formally at the end of two years, when they become "Scholars"; 3. at the end of the third year, when they become "Inceptors"; and 4. formally at the end of the fourth, when they become "Licentiates".

The Entrance Examination, which is the only one requiring notice here, has for its one object that of ascertaining the suitable preparation of the Candidate for attending and profiting by the University Lectures. He is made to construe Greek and Latin books, and to translate into Latin, with this sole object. For the same reason he is examined in the Catechism, and in the first elements of Ancient Geography, Chronology, History, Arithmetic, and Geometry.

There is a private Collegiate Examination at the end of every Term.

Those who are destined for Professions, ordinarily betake themselves to the Faculties of Medicine, Science, etc., after passing the Examination for the Scholarship at the end of two years from entrance.

XIV. The Academical Year or Session lasts from the beginning of November to nearly the end of July. It is divided into three terms, before Christmas, and before and after Easter.

Further information concerning the University may be obtained from the Annual Calendar, the Prospectus, and other Papers, all of which may be obtained by letter, or on application, to Thomas Scratton, Esq., the Secretary, at his Office, 87 Stephen's Green, where he is to be found daily from ten to four, Sundays and Holydays excepted.

University Calendar.

MICHAELMAS, 1857.

UNIVERSITY OFFICERS.

Rector.

Very Rev. J. H. Newman, D.D.

Vice-Rector.

Vacant.

Professors, etc.

FACULTY OF THEOLOGY.

Allocation, *not fixed.*

Dean—Rev. Professor O'Reilly.

1. *Dogmatic Theology*—Rev. Father O'Reilly, D.D., S.J.
2. *Canon Law*—Very Rev. Laurence Forde, D.D.

FACULTY OF MEDICINE.

Allocation, £1,000.

Dean—Professor MacDermott.

1. *Theory and Practice of Surgery*—Andrew Ellis, F.R.C.S.I.
2. *Anatomy and Physiology*—Thomas Hayden, F.R.C.S.I., and Robert Cryan, L.R.C.S.I., and K. and Q.C.P.I.

3. *Practice of Medicine and Pathology*—Robert D. Lyons, M.B.T.C.D., L.R.C.S., M.R.I.A.
4. *Medical Chemistry*—W. K. Sullivan, D. Ph.
5. *Materia Medica*—Robert MacDermott, B.A., B.M., Trin. Coll. Dub., M. R.I.A.
6. *Medical Jurisprudence*—S. M. MacSwiney, M.D.; L. Dub. Coll. Phys.; M.R.C.S.E.
7. *Demonstrators of Anatomy*—Henry Tyrrell, L.R.C.S.I., and Francis Quinlan, L.R.C.S.I.

FACULTY OF PHILOSOPHY AND LETTERS.

Allocation, £2,000.

Dean—Professor Butler.

1. *Greek and Latin Literature*—Robert Ornsby, M.A.
2. *Greek and Latin Languages*—James Stewart, M.A.
3. *Irish Archæology*—Eugene Curry, M.R.I.A.
4. *Poetry*—D. F. M'Carthy.
5. *English Literature*—Thomas Arnold, M.A.
6. *Italian and Spanish Languages*—Signor Marani.
7. *French and German Languages*—M. l' Abbé Schürr.
8. *Ancient History and Geography*—Peter le Page Renouf.
9. *Modern History and Geography*—J. B. Robertson.
10. *Philosophy of History*—T. W. Allies, M.A.
11. *Political and Social Science*—Aubrey de Vere.
12. *Political Economy*—John O'Hagan, B.A.
13. *Geometry and Elementary Mathematics*—Edward Butler, M.A.
14. *Logic*—D. B. Dunne, D.D., D. Ph.
15. *Fine Arts*—J. H. Pollen, M.A.
16. *Catechist in Creed and Scripture*—Rev. W. G. Penny, M.A.

FACULTY OF SCIENCE.

Allocation, £1,000.

Dean—Professor Lyons.

1. *Mathematical Science*—Edward Butler, M.A.

2. *Natural Philosophy*—Henry Hennessy, M.R.I.A.
3. *Physiology*—Robert D. Lyons, M.B.T.C.D., L.R.C.S., M.R.I.A.
4. *Physical Chemistry*—W. K. Sullivan, D. Ph.
5. *Engineering*—Terence Flanagan, M.I.C.E.
6. *Architecture*—J. J. MacCarthy, M.R.I.A..

Secretary.

Thomas Scratton, B.A.

Examiners.

1. Rev. Father O'Reilly, D.D., S.J., Professor Dogmatic Theology.
2. Morgan W. Crofton, Esq., M.A., late Professor of Nat. Phil., Queen's College, Galway.
3. Robert MacDermott, M.B., Professor Materia Medica.
4. W. H. Scott, M.A., late Fellow of Brasenose College, Oxford.
5. Rev. Father Kelly, S.J.

Chaplains.

Rev. James Quinn, D.D.
Rev. Matthew Quinn, D.D.
Rev. Robert Dunne.
Rev. Hugh Macmanus, D.D.
Rev. James Doyle, D.D., Sacristan.

Preachers for the Session of 1856–57.

Residents.

1. The Rector.
2. The Professor of Dogmatic Theology.
3. The Professor of Canon Law.
4. The Dean of St. Patrick's House.
5. The Dean of St. Laurence's House.
6. The Dean of the University Church.

Deans and Tutors of Houses.

St. Patrick's House—Dean, Very Rev. M. Flannery, V.G.; Tutor, Vacant.

St. Mary's House (Rector's)—Dean, Rev. W. G. Penny, M.A.; Tutor, W. H. Scott, M.A.

St. Laurence's House—Dean, Rev. James Quinn, D.D.

Carmelite House—Dean, Very Rev. Father Bennett, O.C.C., Provincial.

CATHOLIC UNIVERSITY.

MEDICAL, ETC., BURSES.

The following Courses are prescribed respectively for Students holding Medical or Scientific Burses, and Students who contemplate entering the School of Civil Engineers.

COURSE OF STUDY FOR STUDENTS HOLDING MEDICAL BURSES.

FIRST YEAR.

Mathematics	Three Terms
Latin and Greek Languages	"
English History, Language, and Literature	"
Modern Languages	"
Ancient History	"

SECOND YEAR.

Logic	
Modern Languages	Three Terms
Latin	Two Terms
Modern History	Three Terms
Chemistry	"

COURSE OF STUDY FOR STUDENTS PREPARING TO ENTER THE SCHOOL OF CIVIL ENGINEERS.

FIRST YEAR.

Mathematics	Three Terms
Latin and Greek	"
History and Geography	"
Modern Languages	"
Drawing	"

SECOND YEAR.

The same as for the first year, with the addition of Natural Philosophy.

PREPARATORY CLASSES.

By permission of the University Authorities, and with a view to the convenience of such members of the Catholic University as may be desirous of qualifying themselves for the Examinations prescribed for appointments in the various departments of the Public Service open to general competition, Courses of study for two years each have been arranged according to the following tables. It must be understood, that these Courses will admit of special modifications to suit the various requirements of individual students.

COURSE OF STUDY FOR THE CIVIL SERVICES.

FIRST YEAR.

Mathematics	Three Terms
English History, Language, and Literature	„
Latin and Greek Languages	Two Terms
French	Three Terms

SECOND YEAR.

Mathematics	Three Terms
French	„
Italian or German	„
Modern History	„
Latin and Greek	One Term
Logic; Moral and Political Science	

COURSE OF STUDY PREPARATORY TO EXAMINATION FOR APPOINTMENTS IN THE ROYAL ARTILLERY AND ENGINEERS.

FIRST YEAR.

Mathematics	Three Terms
Latin and Greek Languages	"
Modern Languages	"
History and Geography	"
Drawing	

SECOND YEAR.

The higher Mathematical and Physical Sciences	Three Terms
English History, Language, and Literature	"
Latin and Greek Languages	"
Modern Languages	"
Logic; Moral and Political Science	
Drawing	
Chemistry, Mineralogy, and Geology	"

FACULTY OF SCIENCE.

SCHEME OF STUDIES AND EXAMINATIONS FOR THE LICENCE IN SCIENCE.

Qualifications for Entering the Faculty.—No student can enter the Faculty of Science, except as an Auditor, unless he has taken a Scholar's degree in the Faculty of Philosophy and Letters. As it is optional with the candidates for that degree to present mathematics or not, and as a certain amount of knowledge of elementary mathematics is absolutely necessary to enable a student to profit by the lectures delivered by the Professors of the Faculty of Science, the student will have to show, previous to his admission to the Faculty, that he possesses a sufficient knowledge of the following subjects, unless he has already presented them at his Scholarship examination and passed creditably, viz.:—

Euclid's Elements of Geometry;
Algebra to Quadratic Equations, inclusively;
Plane Trigonometry;
Elements of Coördinate Geometry.

Qualifications for the Licence in Science.—Whether we look upon mathematics as an instrument of research, or as the science of space and number, it is obviously the basis of all accurate scientific knowledge, and should consequently constitute one of the most important elements of study in a faculty of science. If we recollect also how intimately woven up with one another are the various natural phenomena, and how

difficult, indeed oftentimes impossible, it is to decide to what branch of science a particular class of phenomena should be rightly assigned, it must be evident that, in order to thoroughly comprehend any one department of physical science, in its widest acceptation, we must be more or less acquainted with the elements of all the others. Thus a knowledge of chemistry would be very useful to the physicist, and would in many cases make his researches more fruitful of results than if he was ignorant of it; while it is impossible to study chemistry with profit without a thorough acquaintance with physics, or physiology without chemistry. With a view, therefore, of avoiding such an error as that of allowing students to devote themselves to the special study of any one branch of science, without a proper preparation, the Licence in Science will only be granted to those who shall show by examination proficiency in all the branches of science taught in the Faculty, viz:—

Pure Mathematics.
Mathematical Statics and Dynamics, and Kosmical Physics.
Experimental Sciences.
Natural Science.

In imposing this condition, it is sought to guard against another danger, namely, that the exclusive study of any branch of knowledge is apt to cramp the mind, and communicate to it a one-sidedness which would warp the judgment. The acquirement of a certain amount of knowledge of all the more important branches of science, preparatory to entering upon the special study of any one of them, will obviate this evil, while it will give the student a greater precision of ideas and grasp of mind. These observations apply with equal force to all students, whatever be their objects in entering the Faculty—whether for the pursuit of knowledge for

its own sake, or to qualify themselves for the duty of imparting instruction to others, or for professional or industrial purposes.

Course of Study.—The studies necessary for obtaining a Licence in Science will occupy two years. The following outline of the various courses to be delivered in the Faculty during that period, and in which the subjects of each year's course are indicated, will serve to convey an idea of the system of instruction to be pursued by the Faculty:—

Outline of the various Courses of Lectures to be delivered in the Faculty of Science.

I. MATHEMATICS.

FIRST YEAR.

Spherical Trigonometry—Theory of Equations.
Coördinate Geometry.
Elements of Differential and Integral Calculus.

SECOND YEAR.

Differential and Integral Calculus.
Calculus of Variations.—Calculus of Finite Differences.
Higher Geometry.
Higher Algebra.

II. PHYSICS.

FIRST YEAR.

1. GENERAL AND EXPERIMENTAL PHYSICS.

PRELIMINARIES.

Matter considered in its most simple properties.

FORCE.

Force, its definition and measurement. Composition and

resolution of parallel forces. Converging forces. Couples. Centre of Gravity. Simple machines.

MOTION.

Relations between time, space, and velocity. Laws of falling bodies. Motion in curves. Quantity of motion. Rotation. Definition and measurement of useful work in machinery.

EQUILIBRIUM AND MOTION OF FLUIDS.

Equilibrium of fluids. Level surfaces. Principle of Archimedes. Floating bodies. Equilibrium of elastic fluids. Physical constitution of the atmosphere.

Motion of fluids. Laws of fluid motion in tubes and channels. Waves.

HEAT.

Dilatation of solids, liquids, and gases. The thermometer. Conduction of heat. Radiation. Latent heat. Specific heat. Fusion and solidification. Evaporation and condensation. Tension of vapours. Dynamical theory of heat.

SOUND.

Propagation of sound in solids, liquids, and gases. Waves in elastic bodies. Nodal points, lines, and surfaces. Reflexion and refraction of sound. Physical theory of music.

LIGHT.

Laws of the propagation and intensity of light. Reflexion and refraction. Indices of refraction. Prisms and lenses. Dispersion of light. Diffraction telescope and microscope. General theory of vision. Double refraction. Polarization by reflexion and refraction. Circular polarization. Epipolic dispersion. Connection of these phenomena with the molecular conditions of different bodies.

ELECTRICITY.

Electrical attractions and repulsions. Conduction. Distribution of electricity. Induction. General theory of statical electricity.

Magnetic attractions. Poles. Magnetic curves. Action of the Earth on magnetic needles.

Electricity considered in a dynamical state. Voltaic batteries. Influence of a current on the magnetic needle. Action of a magnet on electric currents. Attractions and repulsions of currents. General theory of dynamical electricity. Connection of electricity and magnetism. Electro-dynamic induction. Diamagnetism. Sources of electricity. Connection of heat, light, and electricity.

MOLECULAR ACTIONS.

Capillary attraction. Endosmose and exosmose. Crystallographic forms. Elasticity. Mutual dependence and connection of the physical properties of matter.

SECOND YEAR.

2. MATHEMATICAL STATICS AND DYNAMICS.

STATICS.

Equilibrium of a point on a given surface. General equations for the equilibrium of a solid body.

Theory of moments.

Attractions of spheroids.

DYNAMICS.

Equations for the motion of a point. Projectile motion in a circle.

Motion of two mutually attracting bodies.

Motion of a point on a given surface.

The pendulum.

Equations for the motion of a solid body.

Rotation.

Moments of inertia, and their relations to the principal axes of solid bodies.

General principles of dynamics.

EQUILIBRIUM OF FLUIDS.

General equations. Level surfaces. Application to elastic fluids.

FLUID MOTION.

Equations of motion in incompressible fluids, with applications. Motions of elastic fluids.

SECOND YEAR.

3. KOSMICAL PHYSICS.

Spherical appearance of the heavens. Grouping of the stars. Star systems. Apparent motion of the stars. Motions of the sun and planets. Methods for deducing the true from the apparent motions. Parallax. Refraction. Aberration. Precession and nutation. Physical aspect of the sun, moon, and planets. Comets. Double stars. Coloured stars. Nebulæ.

Terrestrial latitudes and longitudes.

Determination of the figure and dimensions of the earth from geodesical measurements. Use of the pendulum and barometer in studying the structure and figure of the earth. Universal gravitation. Statics of our planetary system. The figures of the planets and their satellites. Dynamics of the heavenly bodies. Motions of the planets and satellites. Motions of the comets. Motions of double stars. Proper motions of the stars. Rotation of the heavenly bodies around

their centres of gravity. Connexion between the statical and dynamical conditions of the earth and its internal structure. Proofs of the original fluidity of the earth. Proof of the fluid condition of the interior of the earth at the present day. Reaction of the interior fluid mass on the exterior solid crust. Elevation of mountains, islands, and continents. Volcanos and earthquakes. Variations in the distribution of land and water at the earth's surface. Tides and currents. Terrestrial climate. Isothermal lines, and the causes which influence their configuration. Motions of the atmosphere. Winds and storms. Hygrometric condition of the atmosphere. Rain and dew. General view of the laws and phenomena of terrestrial magnetism. Connexion between these phenomena and the internal structure of the globe. Influence of the sun and moon on magnetic phenomena.

III. CHEMISTRY.

FIRST YEAR.

1. GENERAL THEORETICAL CHEMISTRY.

Generalities. Chemical equivalents; nomenclature and notation.

History, preparation, physical and chemical properties of each of the metalloids. Most important of the compounds formed by the metalloids with one another.

Laws of combination by weight and volume, deduced from the study of the combinations of the metalloids. Establishment of the equivalents of the metalloids from their combinations.

Physical and chemical properties of the metals. Combinations of the metals with one another. Alloys.

Action of oxygen, sulphur, chlorine, etc., upon metals. Physical and chemical properties of oxides, sulphides, chlorides, etc.

Salts.

Generalities on organic substances. Proximate and elementary analysis of organic bodies.

Ternary proximate principles of plants:—Cellulose, starch, inuline, dextrine, gums, pectin and other gelatinous principles of plants, sugars, mannite, glucosides.

Alcoholic fermentation—alcohol and ether. Simple and compound ethers; alcohols. Volatile acids derived by oxidation from alcohols. Aldehydes, acetones, etc., and the acids related to them.

Non-volatile organic acids which yield pyrogenous acids by the action of heat. Pyrogenous acids derived from non volatile organic acids.

Organic alkalies or alkaloids.

Essential oils, camphors, resins, etc.

Carbides of hydrogen.

Neutral fat bodies.

Animal bodies.

SECOND YEAR.

2. PHYSIOLOGICAL CHEMISTRY.

Comparative chemical composition of different natural families of plants. Relation between the form and composition of plants.

Comparative chemical composition of the different tissues and fluids of animals.

SECOND YEAR.

3. CHEMICAL PHYSICS.

Elementary principles of crystallography.

Chemical relations of heat: Influence of chemical composition upon the dilatation of bodies. Maximum density of

saline solutions. Relation between the fusing and boiling points of bodies, and their composition. Elastic force and density of gases and vapours. Relation between the specific heat of bodies and their chemical equivalents. Heat developed by chemical combination. Thermo-chemical laws. Calorimetry. Different methods employed to determine the specific heat and the heat of combination of bodies. Theories of combustion. Chemical relations of radiant heat.

Chemical relations of light: chemical and molecular changes induced in bodies by the action of light. Influence exerted by bodies upon the refrangibility of light. Rotatory or circular polarization of liquids and gases. Correlation between crystallographic form and optical properties.

Electro chemistry: Chemical properties of electricity. Chemical action of electrical discharges. Laws of electro-chemical decomposition. Different kinds of voltaic batteries. Electro-chemical theories. Classification of bodies founded upon their electrical relations.

Chemical statics and dynamics.

Molecular constitution of bodies.

Stœchiometry.

IV. MINERALOGY.

SECOND YEAR.

Generalities. Morphology of minerals. Structure of minerals—crystalline, spheroidal, and amorphous states of aggregation.

Physical characters of minerals:—Cleavage and fracture; hardness; tenacity; specific gravity; magnetism; electrical properties; optical properties; lustre; colour; pellucidity; phosphorence.

Chemical properties of minerals. Chemical constitution

of minerals. Equivalents of minerals—formulæ. Influence of chemical constitution upon form, etc.:—Dimorphism; isomorphism; allotropism; isomorphic replacement; polymeric isomorphism. Determination of minerals.

Classification and physiography of minerals.

V. GEOLOGY.

SECOND YEAR.

(Geognosy, *or the chemical and mechanical structure of the Earth's crust, and the changes which it undergoes from the action of chemical and mechanical agencies*).

1. Lithology. Minerals which form rocks. Division of rocks into: mechanically formed rocks, organically formed rocks, metamorphic or altered rocks, and crystallized rocks.

Water as a geological agent:—Mechanical action of water in the solid and liquid state. Chemical action of water in the liquid and gaseous state.

The atmosphere as a geological agent.

Geological agency of Heat.

Pseudomorphism. Paragenesis of minerals. Comparative physiography of the minerals of different geological districts.

2. Petrology. Stratification; lamination; joints; spheroidal and columnar structure; cleavage, etc.

Modes of occurrence of igneous rocks.

Phenomena connected with the elevation and depression of rock masses:—Faults, fissures, dykes, veins, etc. Unconformability of rocks. Mineral veins.

Changes produced by the action of water upon rock masses.

Metamorphic action of heat.

Classification of rocks.

VI. PHYSIOLOGY.

FIRST YEAR.

Relations of the animal and vegetable kingdoms.

Outlines of the history of the animal kingdom, recent and remote.

Animals as distinguished from plants.

Organization and life of animals.

General view of animal kingdom.

Structure of animals.

Skeletoid and A-skeletoid animals.

Archetype skeleton. Osseous system of animals.

SECOND YEAR.

Of the fluids of the animal system.

Of the circulating fluid and the laws of the circulation.

Of the digestive system, and of digestion, assimilation, nutrition, growth, and metamorphosis of tissues.

Of the respiratory system, and of respiration.

Of the nervous system, of the brain, spinal cord, etc.

Histomorphism or Elementary Form and Structure of tissue.

Of Histo-genesis and Histolysis.

Special Histo-morphism or Histology of the Blood and fluids generally, and of the solid tissues.

Outlines of Economic Physiology—Animal and Vegetable.

Examinations.—At the end of two years spent in these studies, an examination will be held, at which the student must satisfy the examiners that he has attained sufficient proficiency to qualify him for his licence. But, as the student's proficiency may entitle him not only to his licence, but also to honours, the examination will be so conducted as to afford him an opportunity of establishing his claim to the latter. It will, therefore, have a double scope, to ascertain whether

he has reached (1) the standard of *necessary* proficiency; or (2) that of *meritorious* proficiency.

Examinations for necessary proficiency.—In order to determine whether the student is profiting by his studies, and especially if he is in the way to obtain his licence, it is proposed that an examination similar to the Inceptorship examination in the Faculty of Philosophy and Letters, be held at the end of the first year, in the following subjects, which constitute accordingly the first year's course, as already indicated.

1. Elementary Mathematics.
2. General Experimental Physics.
3. General Theoretical Chemistry.
4. Elementary Physiology.

If the student passes creditably in these subjects, he may enter upon the second year's course, the subjects of which are:—

1. The higher Mathematics.
2. Mathematical Statics and Dynamics.
3. Kosmical Physics.
4. Chemical Physics.
5. General Physiology and Physiological Chemistry.
6. Mineralogy and Geology.

The subjects for *necessary* proficiency at the final examination for the license in Science will consist of

1. Mathematical Statics and Dynamics.
2. Kosmical Physics.
3. Chemical Physics.
4. General Physiology and Physiological Chemistry.
5. Mineralogy and Geology.

Examination for Honours.—After the candidate has creditably passed his examination in the five subjects just men-

tioned, and obtained his licence, he may become a candidate for honours. Two at least of the subjects taught in the faculty must be presented for the honour examination, and the candidate is at liberty to select any two he pleases. With the view of guiding the student, and encouraging the special study of sciences which have an intimate relationship, the following scheme, in which the cognate sciences are grouped together, is suggested for selection:—

1. Higher Mathematics. Mathematical Statics and Dynamics, and Kosmical Physics.

Or 2. Kosmical Physics, Mathematical Dynamics and Statics. Experimental Physics.

Or 3. Experimental Physics. Theoretical Chemistry and Chemical Physics.

Or 4. Theoretical Chemistry (chiefly *inorganic*). Mineralogy and Geology.

Or 5. Theoretical Chemistry (chiefly organic). Physiology.

There is of course no objection to a student presenting more than two subjects, or all if he chooses.

Exhibitions.—With the view of still further promoting a higher cultivation of science, burses will be established in connection with the different subjects taught in the Faculty, which will be open to competition to those licentiates in science who have obtained honours in any of the subjects in the preceding lists. These burses may be held for three years, that is, until the student is in a position to proceed to his fellowship examination, subject, however, to the condition that the holder of the burse must act as assistant to the professor of that science in connection with which he holds his burse.

Higher degrees.—If the student desires to obtain the

higher collegiate degree of Fellowship in Science, he may, after he has obtained his license, and thus prepared himself for the special study of one or more branches of science, enter upon the study of those which he intends to present for his fellowship examination, which, unlike that of licentiate, will be granted for superior knowledge in special subjects, such as the higher mathematics, physics, chemistry, or physiology.

Practical Instruction.—It being now universally admitted that the higher instruction in science can only be given where the most ample means are afforded, not only of illustrating the lectures of the professors, but of enabling all the students to become practically conversant with the methods of investigation adopted in each science, the Faculty of Science will be provided with an Observatory, Laboratories, Zoological, Botanical, and Mineralogical Cabinets. The Physical Cabinet has been already furnished with some of the principal apparatus required for the illustration of experimental Physics. The Chemical Laboratory, now completed, and which will be ready for the reception of students in the next session, is not inferior to the best laboratories of other Universities, and will, it is to be hoped, afford students every facility for the cultivation of that important and practically useful science, Chemistry. The other laboratories will be fitted up in a corresponding manner. Cabinets of Natural History and Mineralogy can only be formed by the slow growth of time; but already some progress has been made to provide the *necessary* part of the mineral collections, and steps will be taken towards the early establishment of the others.

SYLLABUS

OF

THE LECTURES

ON

THE HISTORY OF GREEK PHILOSOPHY,

DELIVERED BY MR. RENOUF, IN THE CATHOLIC UNIVERSITY OF IRELAND, DURING THE SUMMER TERM OF 1858.[1]

INTRODUCTION.

Conception of the History of Philosophy. Ancient and modern historians of Philosophy. General characteristics of Greek Philosophy—are foreign influences to be admitted? Greek conception of Philosophy—its principal periods—how determined? The Greek Mind contrasted with the oriental, Roman, etc. Relation of Philosophy to other departments of Greek culture. Politics, Commerce, Literature, Art, Science, and Religion in the sixth century B.C.

Sources: 1. Original works; 2. Fragments or references in Plato, Aristotle, Theophrastus, Cicero, Seneca, Plutarch, early Christian writers, Sextus Empiricus, Diogenes Laertius, Stobæus, Simplicius, etc. Respective values of these authorities. Spurious productions.

Chronology of the Greek Philosophers.

FIRST PERIOD.

FROM THALES TO SOCRATES:

1. The Ionian φυσιολόγοι. Why is Philosophy made to date from Thales? Thales, Anaximander, Anaximenes, Diogenes of Apollonia.

[1] Gentlemen following these Lectures will do well to provide themselves with "Historia Philosophiæ Græcæ et Romanæ ex fontium locis contexta. Locos collegerunt, etc., H. Ritter, L. Preller", 2nd Edit., Gotha, 1856.

2. The Pythagorean School. Its external history. Authorities for the life and doctrines of its founder. The Pythagorean principle—its development. Harmony and Arithmetic. God, Nature, and the human soul. Ethics.

3. The Eleatic Speculation. Its beginning, systematic formation, completion, and dissolution. Xenophanes of Colophon, Parmenides and Zeno of Elea, Melissus of Samos.

4. Heraclitus—*ὁ σκοτεινὸς*. Should he be included among the "Ionians"? Relation of his system to the Eleatic—and Pythagorean. *ἐκ πάντων ἓν καὶ ἐξ ἑνὸς παντα—πῦρ νοερόν—ῥοή—πόλεμος πατὴρ παντων—τῶν διαφερόντων ἁρμονία—εἱμαρμένη—λόγος ἐκ τῆς ἐναντιοδρομίας—ὁδὸς ἄνω, κάτω.*

5. Empedocles of Agrigentum. *τέσσαρα ῥιζώματα—σφᾶιρος—φιλία, νεῖκος—κόσμος αἰσθητός, νοητός.*

6. The Atomists, Leucippus and Democritus—*τὸ πλῆρες—ἄτομον—κενόν—συμπλοκή—ἀλλοιώσεις—ἀνάγκη, τύχη—παλμός, ἀντιτυπία—δίνη—εἴδωλα—γνώμη γνησίη, σκοτίη*—the three *κριτήρια—εὐθυμία.* Relation of this school to earlier and contemporary schools. [Parallel relation of Leibnitz to Spinoza.] What truth is there about its Empiricism, Materialism, and Atheism? Democritus on Marriage and Patriotism. His Ethics.

7. Anaxagoras. *Νοῦς—τὰ ὁμοιομερῆ—περιχώρησις—διάκρισις, σύμμιξις, ἀπόκρισις—οὐδεν γίνεσθαι.* Which of the fundamental notions in the system is the dominant, which secondary? Relation of this system to earlier and contemporary systems. Plato and Aristotle on Anaxagoras.

8. The Sophists. Protagoras, Gorgias, Diagoras, Prodicus, and other remarkable Sophists. Their relation to the general culture of the age—to public life. Their place in the history of Greek Philosophy. Intellectual culture of Greece in the fifth century B.C.

SECOND PERIOD.

SOCRATES, PLATO, AND ARISTOTLE.

Character of this, as distinguished from the foregoing and following Periods. Process of its development.

Socrates. His Life, Judgment, and Death.

Authorities for his doctrine. Xenophon, Plato, Aristotle, later writers—how reconciled? "Worth of Socrates as a Philosopher". His idea of Science—its development. The Socratic ἄγνοια, μαιευτική, ἔρως, εἰρωνεία. Induction. The δαιμονίον. His criticism on former systems of Physics—and Theology. His own ethical system. Virtue an ἐπιστήμη [ὥσθ' ἅμα συμβαίνειν εἰδέναι τε τὴν δικαιοσύνην κὰι εἶναι δίκαιον.] Duties of Man (1) to himself, ἀνδρεία, ἐγκράτεια, etc.; (2) to others, δικαιοσύνη; (3) to the Divinity, εὐσέβεια. Virtue and happiness inseparable. εὐτυχία and εὐπραξία. The soul immortal and divine through reason.

Minor Socratic Schools.

1. The School of Megara. Euclid, Eubulides, Diodorus Cronos, Stilpo, Menedemus. Schools of Eretria and Elis. Socratic, Eleatic, Sophistic elements in the Megarian doctrine. Germs of the doctrine of Ideas.

2. The Cynics. Antisthenes, Crates, Diogenes, Hipparchia. Affinity with the Megarians. Difference between the two schools. Stilpo.

3. The Cyrenaics. Aristippus. Division of Ethics: 1. περί τῶν αἱρετῶν καὶ φευκτῶν. 2. περὶ τῶν παθῶν. 3. περὶ τῶν πράξεων 4. περὶ τῶν αἰτίων. 5. περὶ τῶν πίστεων—ἡ μερικὴ or μονόχρονος ἡδονὴ man's τέλος, not εὐδαιμονία, why? the two πάθη or three καταστάσεις περὶ τὴν ἡμετέραν σύγκρασιν. Notion of ἡδονή—worth of actions. Principle of the Cyrenaic Ethics—its relation to the physical and dialectic theory. Is this school a true offshoot of the Socratic philosophy? Theodorus, Hegesias, Anniceris.

PLATO.

Plato's Life. His writings—genuine and spurious works—means of distinguishing between them. Classification of the dialogues—ancient and modern attempts: (1) from internal philosophical cha racter, Thrasylus, Aristophanes of Byzantium, Sextus Empiricus—Diogenes Laertius—Serranus—Petit—Geddes—Eberhard—Schleiermacher—Ast—Van Heusde—Brandis; (2) from chronological data, Tenneman—Socher—Hermann.

Historical position of the Platonic system with reference to its predecessors—and to the Aristotelian.

Platonic method—its scientific characteristics, as distinguished from those of Socrates and Aristotle—its dialogic form.

Trichotomy of the system—Dialectics, Physics, Ethics—order of these divisions.

Preliminary investigations. Philosophic Thought as distinguished (I.) from unphilosophic, (*a*) *theoretically*, *ἐπιστήμη* contrasted with *αἴσθησις*, *δόξα*, *μανία*, *ἐνθουσιασμός*, (*β*) *practically*, true virtue contrasted with *ἀρετὴ δημοτική*. (II.) from *ἡ σοφιστική*. (III.) considered in itself, (*a*) its starting point *ἔρως*, (*β*) its development through the dialectic method—functions of *συναγωγὴ* and *διαίρεσις*—*ἐξ ὑποθέσεως σκοπεῖν*. (IV.) Progressive steps of the philosophical education from "music" to dialectics. Plato's conception of philosophy—its relation to other sciences—its possibility.

DIALECTICS. Elements of Plato's doctrine of Ideas in earlier philosophical systems. Definition and nature of the *εἴδη*—according to Plato—and Aristotle. The *εἴδη* wrongly taken (1) for sensible substances (*αἰσθητὰ ἀΐδια*), (2) for subjective conceptions (*νοήματα*) of the human or divine Reason. Difference and plurality in the *εἴδη*. The world of Ideas—its limits. What things have *εἴδη* corresponding. Relation of this plurality of Ideas to the unity of their essence. The system of Ideas—*τὸ ἀγαθόν* and its relation to other Ideas. The Ideas as *ἀριθμοὶ νοητοί*.

PHYSICS. The Phenomenal world and its relation to the Ideal. Four classes of Being—*τὸ ἄπειρον*, *τὸ πέρας*, *τὸ ἐξ ἀμφοῖν τούτοιν ξυμμισγόμενον*, *ἡ αἰτία τῆς ξυμμίξεως*. Matter according to the Philebus—and Timœus. Evidence of Aristotle. Matter not a substance—nor yet something merely subjective (Ritter)—what it is. Immanence of sensible phenomena in the Idea. Deduction of the phenomenal from the *εἶδος*. Contradiction in the Platonic doctrine. The Soul of the World. Origin of the World—question of its eternity—its elements. The world a perfect *ζῶον*. The human soul—mythical history of its origin, preëxistence, and future state. Divisions of the Soul—the Rational and Irrational—the Irrational divided into the *ἐπιθυμητικὸν* and the *θυμοειδές*. Free Will. Connection of the Ethics with the Physics.

ETHICS. *τὸ ἀγαθὸν*—its nature and its elements. Virtue. Variations in Plato's doctrine. The different virtues—how determined.

The Platonic compared with the Cyrenaic and the Cynic Ethics. POLITICS [Analysis of the Republic]. The State—its notion—its necessity—its component parts—its constitution. Education of the citizens—community of goods and wives. Plato's Republic not meant as a mere *ideal* State, in the modern sense. Its connection with the entire Platonic system. How far agreeing with the Hellenic conception of the State. To what extent explained by the political events of the period. ÆSTHETICS. Plato's views on Beauty and Art. [Raphael's letter to Castiglione.]

Relation of the Platonic philosophy to Religion. Idea of Divinity—personality of God—the popular religion and its gods.

Doctrinal differences between the "Laws" and all other writings of Plato—not greater in politics than in dialectics, physics, psychology, ethics—how accounted for.

The OLD ACADEMY. Plato's School—Speusippus, Xenocrates—Crantor and Polemo.—The Epinomis.

ARISTOTLE.

Aristotle's Life. His writings—their fate—ancient catalogues—exoteric and esoteric works. Present order and form of Aristotle's works—how explained. Composition of the Organon, Metaphysics, Physics, Nicomachean Ethics, Politics, Rhetoric, etc. Spurious works—tests of genuineness.

1. Doctrine of Science.

Aristotle's conception of Science—how far agreeing with Plato's? its divisions—under which is Logic included? The Organon—origin of the name—connection and succession of the logical treatises according to the notions of Analytics and Dialectics. Place of the "Categories".

(*a*). *Analytics*. Theory of the Proposition—arrangement of the treatise *περὶ ἑρμηνείας*.

Theory of the Conclusion—Prior Analytics, Books I. and II.

Theory of Apodictic Proof—Analytical arrangement of the Posterior Analytics. Incompleteness of the theory—how explained.

(*b*). *Dialectics*. Plan of the "Topics" and "Sophistical Elenchi"—connection of the two treatises.

The "Categories"—transition from Logic to Metaphysics.

Place of the Aristotelian Logic in the history of Logical Science.

Origin of Cognition—nature of experience—relation of sense to experience—and of experience to knowledge—which is the highest principle of knowledge? special and subordinate principles. Theoretical and practical Reason. Identity of Subject and Object in cognition.

2. The First Philosophy.

[Analysis of the fourteen books of the Metaphysica.]

Aristotle's criticism of his predecessors—particularly Plato—notion of the "First Philosophy"—the four causes—their reduction to two—and the relation between them. Virtuality and Actuality. Relation of ἐντελέχεια to ἐνέργεια—the universal and the individual—the three kinds of Substance. Notion of the First Mover—deduction of His attributes.

3. General Physics.

[Contents, division, and analytical arrangement of the "Naturalis Auscultatio".]

Notion of Nature—difference from Art—from the object matter of Mathematics. Motion—what? and of how many kinds? its mechanical conditions—Space and Time—(discussion of the Void)—its dynamic condition, τὸ οὗ ἕνεκα. The Infinite. Teleology of Nature, τύχη and αὐτόματον—opposition of matter and form—τέρατα.

4. Special Physics.

[The four books "de Cœlo", the two books "de Generatione et Corruptione", etc.]

Theory of the Elements—Æther the πρῶτον στοιχεῖον—arrangement of the universe—series of spheres—Heaven—the fixed stars, the planets, and Earth. Organic nature—progressive development ἀπὸ τῶν ἀψύχων εἰς τὰ ζῶα δία τῶν ζώντων οὐκ ὄντων δὲ ζώων—elementary life—life of plants—of animals—of man—man the perfection and end of nature.

5. Anthropology.

[Analysis of the three books "de Anima", and the "Parva Naturalia".]

The Soul—its definition—its relation to the body—its three parts

and their functions. Perception—the five senses—peculiar importance of the Touch—the *αἰσθητήριον κοινὸν*—*φαντασία*—dreams—*μνήμη* and *ἀνάμνησις*—*ὄρεξις*. Reason—active and passive—its function—its relation to sensation and *φαντασία*. Identity of Reason "in actu" with its object—*ἡ ψυχὴ τὰ ὄντα πως ἐστι πάντα*. The Will. The Soul an indivisible unit. [Contradiction in the theory.] Theory of locomotion—what is the motive principle in animals? Origin of the Soul—death and immortality. Freedom of the Will—transition to Ethics.

6. Ethics.

The four different Ethical works attributed to Aristotle.

[Analysis of the Nicomachean Ethics.]

Theory of Virtue. Of moral freedom as a condition of Virtue. The ethical virtues. *Δικαιοσύνη*. The Dianöetic virtues. Heroic virtue and *θηριότης*. *Ἐγκράτεια* and *καρτερία*. Friendship and Love. Pleasure and Happiness. Transition to Politics.

Aristotle's criticism of other ethical systems. What is the scientific value of his own?

7. Politics and Economics.

[Analysis of the "Politics". Order of succession of the books. Contents of the "Economics". Spuriousness of the Second Book—authorship of the first.]

Notion of the State—presupposes that of the Family—relations of husband and wife, father and child, master and slave. Purpose of the State. The State not an aggregate but an organic whole. Organic relations of (1) the families, (2) citizens and subject residents, (3) the governing and the governed. Identity of the State depends upon its retaining its constitution. Relation of the constitution to legislation. Three *ὀρθαὶ πολιτεῖαι*, their *παρεκβάσεις*—the *συνδυασμοί*. Disturbing and preserving causes in the different constitutions. Theory of the best *πολιτεία*—the external conditions for its realization—the internal. Education of the citizens. The science of politics reflected to the point from which it started. Aristotle's criticism of various historical constitutions—and of Plato's 'Republic' and 'Laws'.

Relation of the Aristotelian Philosophy to Art and Religion.

The Peripatetic School. Eudemus and Theophrastus—Dicœarchus, Aristoxenus, Strato.